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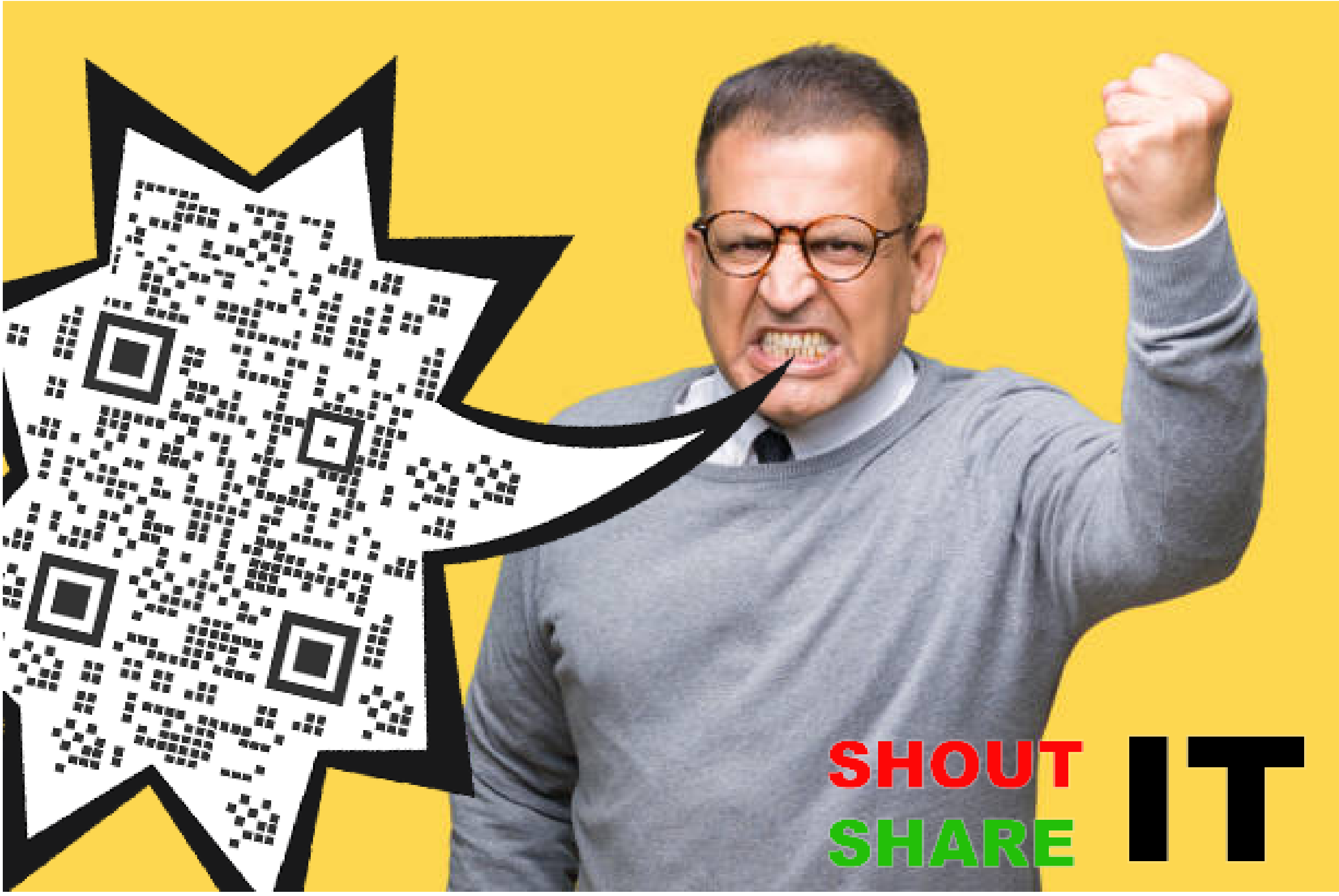
Bulletin 7

Fall Bird Migration on the Gaspé Peninsula

by

Stanley C. Ball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Fall Bird Migration
ON THE
Gaspé Peninsula

BY

STANLEY C. BALL

Curator of Zoology, Peabody Museum

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FALL BIRD MIGRATION ON THE GASPÉ PENINSULA

INTRODUCTION

SCOPE OF THE WORK

This Bulletin presents the data recorded during the summer and fall periods 1935–1941 and 1946–1951, concerning autumn migration as seen and heard on the Gaspé Peninsula. Geographically, the position of the peninsula aroused interest as to the behavior of its resident birds as well as transients from the north (Fig. 1). It lies south of the wide mouth of the St. Lawrence River, with Anticosti Island 45 miles away, and the southern shore of the Labrador Peninsula 75 miles distant. St. Lawrence Gulf on the east extends 225 miles to Newfoundland. In the south-central part of the gulf the Magdalen Islands possess an avifauna that is largely migratory. Although birds from the Magdalens could only accidentally reach the Gaspé coast, these little islands lie in the path of birds believed to cross the gulf from Anticosti and southern Quebec. Prince Edward Island, 55 miles east of the Magdalens, is similarly in line of flight from Newfoundland to Nova Scotia.

It was first planned to study on the Forillon (Fig. 2), the 5-mile-long northeasternmost extension of the peninsula north of Gaspé Bay, the inception of migration, the stimuli which cause it, and those directing the birds southward.

The need to broaden the field of observation soon carried the investigations to the northern coast of the peninsula, as well as around Gaspé Bay to the eastern coast and the south shore along Chaleur Bay. Streams of migrant thrushes, easiest to hear among nocturnal migrants, pouring out of the Dartmouth, York, and St. John river valleys into Gaspé Bay, made desirable both population and migration studies of thrushes throughout these valleys, and those of important tributaries. Investigations in the lower part of the Dartmouth, two-thirds of the main St. John Valley, and the entire length of the York and several of its brooks are reported here. The area about York Lake, and of the South Fork arising in high mountains about the Miller Mine Claims nearly 70 miles inland, provided evidence, added to that from Fox River west of the Forillon, that migrating birds moved in general down-valleys. In other words, a radial pattern for the peninsula as a whole began to appear. Full recognition of it followed studies on rivers draining the Shickshock Mountains, in west-central Gaspé, namely the northward-flowing Ste. Anne River and the southward-flowing Cascapedia, Little Cascapedia, and Bonaventure.

The numbers of nesting thrushes found on sample plots one square mile in area formed the basis for estimates of populations on entire watersheds. The total number for the York Valley, when compared with the numbers heard leaving it during the autumn, suggested that all thrushes found migrating

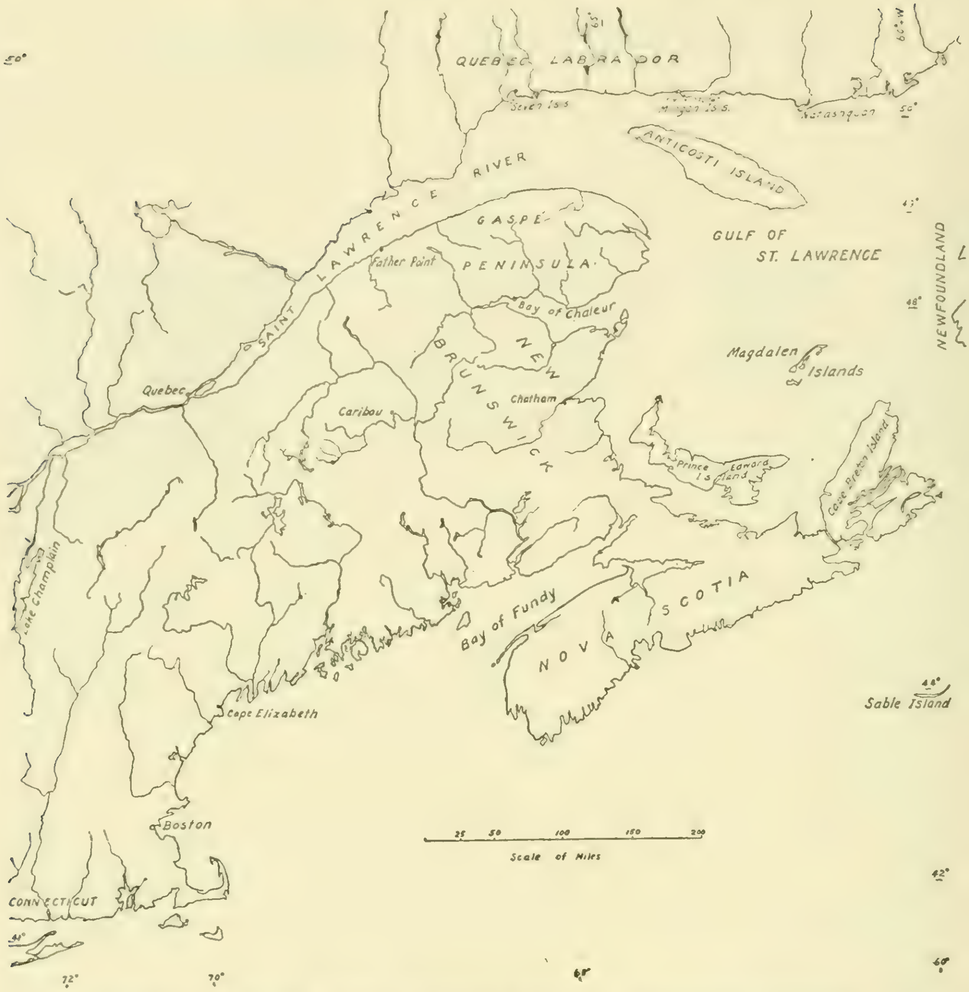

50°
QUEBEC LABRADOR
Seven Is.
Mingan Is.
Natashquan
50°
ANTICOSTI ISLAND
SAINT LAWRENCE RIVER
GASPÉ PENINSULA
Father Point
GULF OF ST. LAWRENCE
NEWFOUNDLAND
48°
Bay of Chaleur
NEW BRUNSWICK
Magdalen Islands
Chatham
Caribou
Quebec
Prince Edward Island
Cape Breton Island
Lake Champlain
NOVA SCOTIA
Bay of Fundy
Cape Elizabeth
44°
Sable Island
Boston
25 50 100 150 200
Scale of Miles
42°
CONNECTICUT
41°
72°
70°
65°
60°

Figure 1. Map of Gaspé Peninsula and the surrounding regions.

down these river valleys before late September were residents of the peninsula. In other words, there was no need to draw upon the vast reservoir lying north of the St. Lawrence for transients crossing the river in a high stratum and on a broad front.

Among the many environmental stimuli assessed in trying to determine which of these might act upon the internal inherent rhythm to set the birds in motion, the annually decreasing length of the daily light period is concluded to be the most promising. It may prevent thrushes from procuring enough food to maintain their energy requirements in the face of lengthening night periods. Light measurements made during several seasons, however, make further investigation desirable to clarify certain apparent discrepancies.

Of the orientational stimuli, considered in the light of radial migration,

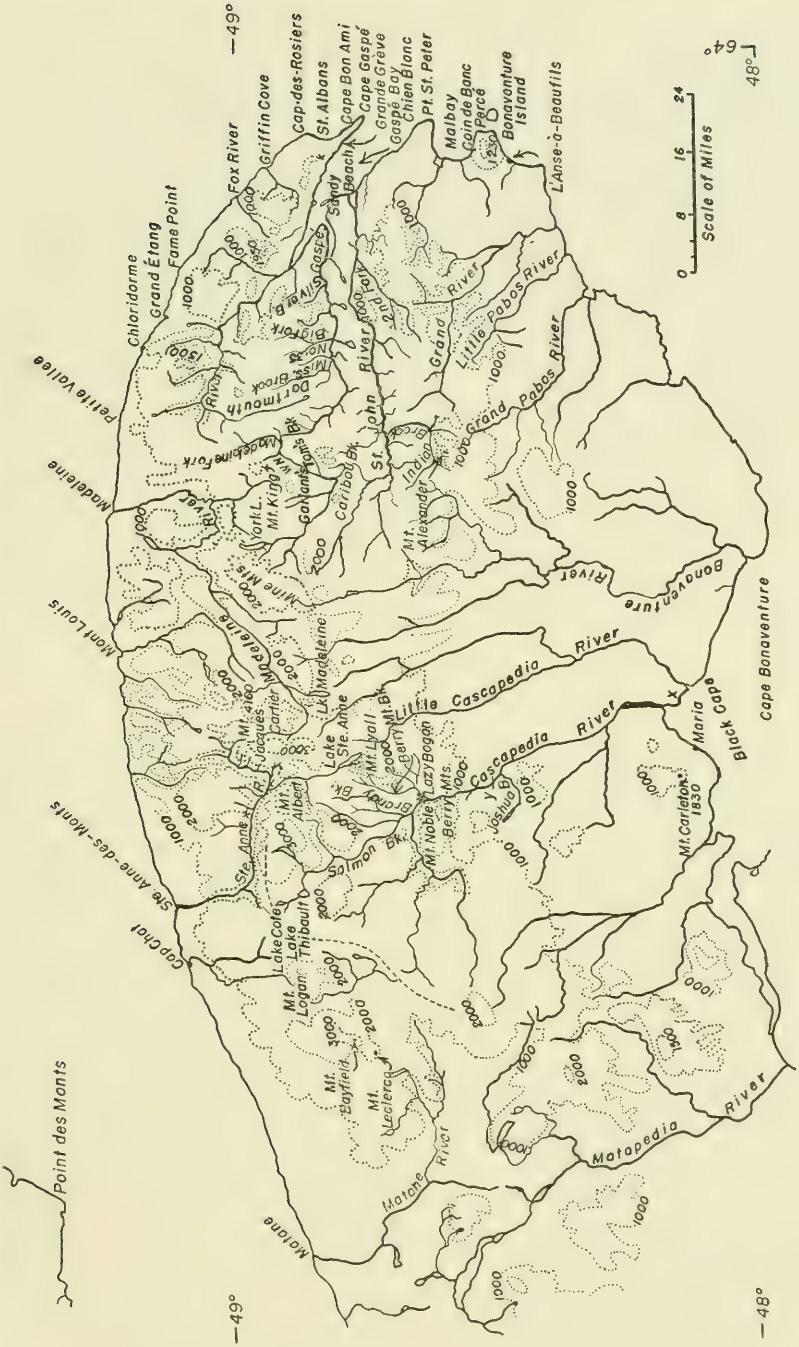

Point des Monts
Matane
Cap Chat
Ste. Anne-des-Monts
Mont Louis
Madeleine
Petite Vallee
Chloridorme
Grand Étang
Fame Point
Fox River
Griffin Cove
Cap-des-Rosiers
St. Albans
Cope Bon Ami
Cape Gaspé
Grande Grève
Gaspé Bay
Chien Blanc
Pt. St. Peter
Sandy Beach
Malbay
Coin de Banc
Percé
Bonaventure Island
L'Anse-à-Beaufils
Dartmouth River
Madeleine Fork
York River
St. John River
Grand River
Little Pabos River
Grand Pabos River
Bonaventure River
Cascapedia River
Little Cascapedia River
Matapedia River
Matane River
Ste. Anne R.
Madeleine R.
Mt. Jacques Cartier 4160
Mt. Albert
Mt. Logan
Mt. Bayfield
Mt. Leclercq
Mt. Lyall
Mt. Noble
Mt. Alexander
Mt. Carleton 1830
Mt. King
Lake Cote
Lake Thibault
Lake Ste. Anne
Lk. Madeleine
York L.
Mine Mts.
Berry Mts.
Lazy Bogan
Joshua B.
Salmon Bk.
Brandy Bk.
Berry Bk.
Indian Brook
Caribou Bk.
Tom's Bk.
Miss. Brook
Big Fork
Cape Bonaventure
Black Cape
Maria
1000
1500
2000
3000
1950
1230
0 8 16 24
Scale of Miles
49°
48°
64°

Figure 2. Map of Gaspé Peninsula.

one especially, the descending horizon line, proved worthy of further study. This led to research at mountain divides and passes; the preliminary results are included in this paper.

Evidence gathered for considering correlative problems whose solution was demanded in order to develop the major theme is also introduced here. Among these were the problems of identification of three species of thrushes by their call notes; the purpose and frequency of these notes; behavior after descent at dawn; length of time spent resting and feeding; length of migratory flights; and efficiency of nocturnal and twilight vision in passerine birds.

Residence was maintained at Grande Grève near the base of the Forillon during the field work there from 1935 to 1941 and also in 1946. Short periods at Mr. Lindsay's camp near Cape Haldimand proved advantageous for studying migration on the south shore of Gaspé Bay, as well as in the York and St. John river valleys. Permanent residence at Sandy Beach from 1947 to 1951 provided continued access to this region. Camps at York Lake, Ross Lake, and several others in northeastern Gaspé were used as bases for inland observations. Farther west, several periods were spent at Ste. Anne des Monts, in the Parc de la Gaspésie, on the Cascapedia River, at strategic points along the Bay of Chaleur, at Percé on the east coast, and at Routierville in the Matapedia Valley. Automobiles made many other areas accessible.

THE REGION

The Gaspé Peninsula is the easternmost part of southern Quebec, bounded on the west by the Matapedia River, on the north by the St. Lawrence, on the east by the Gulf of St. Lawrence, and on the south by Chaleur Bay and the Restigouche River (Fig. 1). Its length is about 150 miles and its greatest width 85 miles. Along the north-central axis of the peninsula extends a belt of Appalachian plateau country dissected by many streams (Figs. 2 and 3). The highest portion, known as the Shickshock Mountains, lies in the west and includes Tabletop, Mt. Albert, and Mt. Logan, averaging about 4000 feet in elevation, and other mountains of more than 3000 feet. Thence the terrain on the east drops steeply to about 2000 feet. This elevation persists for some 30 miles, accented by a few 3000-foot eminences, such as Mts. Brown, Needle, Porphyry, and York. Gradually the height falls to 1000 feet within a few miles of the eastern coast. Southwest of Mt. Logan the Shickshocks continue high for more than 15 miles, with Mts. Bayfield, Matawa, and other peaks exceeding 3300 feet. Beyond Mt. Leclercq the plateau gradually descends toward the headwaters of Matane River.

From the higher axis the descent on the north is at first gradual, then generally precipitous to the shore between Ste. Anne des Monts and Madeleine, but through the rest of its length reaches the coast through gently rolling country that has largely been cleared of forests, and is now occupied by farmer-fishermen. South of the axis the terrain is somewhat lower, particularly east of the Cascapedia River. "To the south of the Shickshocks proper many of the broad, flat-topped areas between river valleys rise to

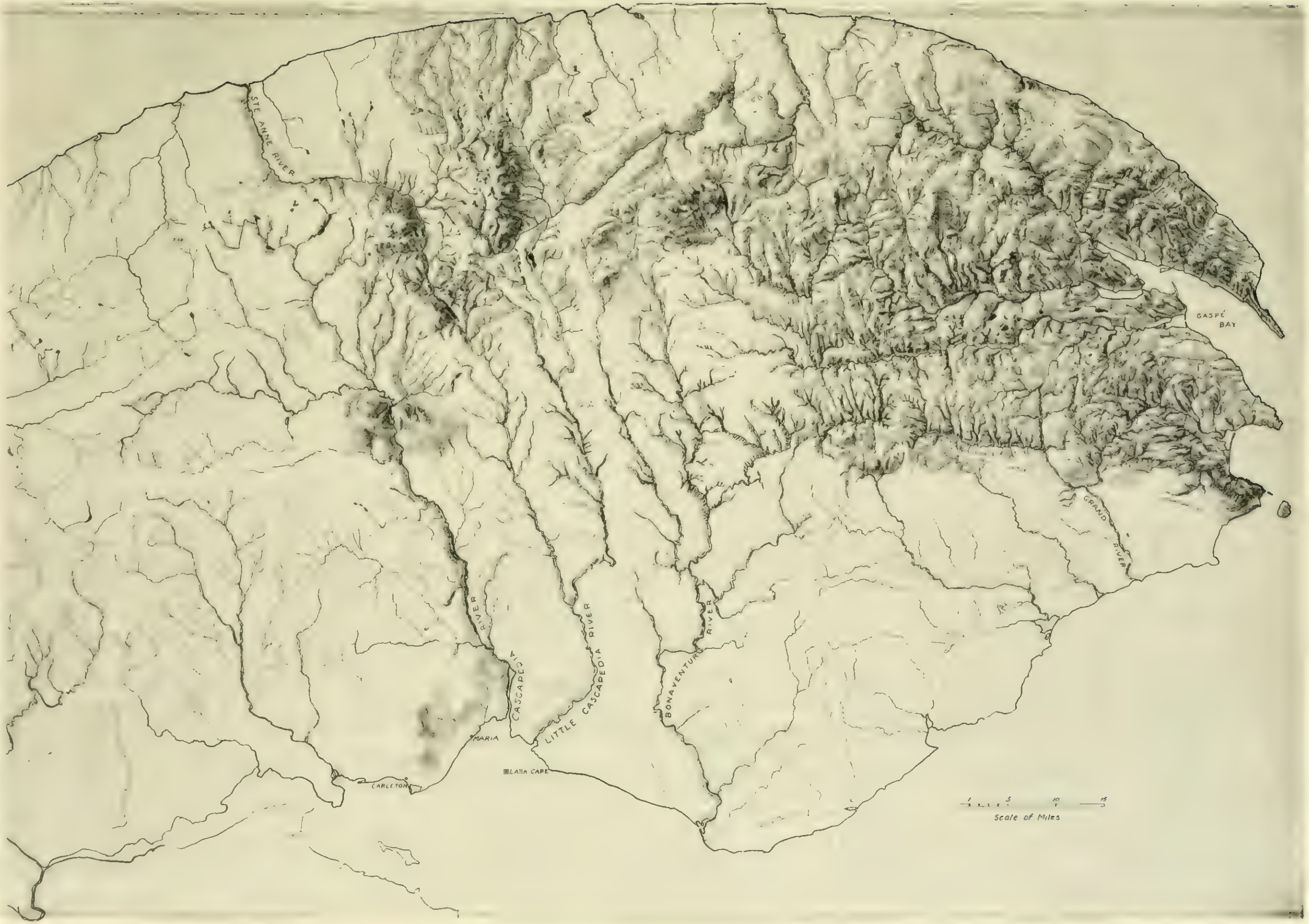

STE ANNE RIVER
GASPÉ BAY
GRAND RIVER
BONAVENTURE RIVER
LITTLE CASCAPEDIA RIVER
CASCAPEDIA RIVER
MARIA
BLACK CAPE
CARLETON
1 5 10 15
Scale of Miles

Figure 3. Relief map of Gaspé Peninsula

1800 and 2000 feet. Throughout the peninsula the most striking feature of the topography is the flat-topped character of the interfluvial areas and the abrupt descent to the valley bottoms. On the flat divides there are occasional ponds and swamps" (Alcock, 1926).

The coastline along the St. Lawrence River, as seen on the map, is a smooth one. Although rugged enough in the vertical plane where the sea has cut away the folds, it is nowhere indented by bays sufficient in size to protect large ships, or birds. However, at the eastern end, Gaspé Bay, some 16 miles long and 5 miles across at its widest part, gives good harbor to ducks, geese, and shore birds, especially in the estuaries of three salmon rivers that enter from the west. These are the Dartmouth, York, and St. John.

Several smaller rivers enter the gulf on the east. More important are the Bonaventure, Little Cascapedia, and Cascapedia, which lead southward from the mountains into the Bay of Chaleur.

To an observer in the valleys the country appears generally rugged. Having ascended to the high plateaus, however, he views a remarkably uniform topography, much dissected to be sure, but presenting an horizon broken only here and there by a mountain a few hundred feet higher.

In the northeast the Appalachians north of Gaspé Bay have been eroded by wave action from the gulf so as to present along the Forillon a continuous precipice some 5 miles in length and from 300 to 700 feet in height (Pl. 2, *C*). Shorter and lower cliffs appear at Percé and on Bonaventure Island, where the mountains south of Gaspé Bay terminate at the gulf.

Except for the summits of the higher Shickshocks, which lie above tree-line, the entire peninsula was forested before the advent of the white man. Even now, cleared land extends but a few miles inland along the lower coastal regions, and somewhat farther on the larger rivers. The original forest was chiefly coniferous, with birch, poplar, maple, and mountain ash gaining a foothold where forest fires, and later lumbering, destroyed the spruce, fir, cedar, and pine.

Northward across the St. Lawrence River lies Quebec Labrador, 30 to 70 miles distant. Anticosti Island on the northeast approaches to within 45 miles of the Gaspé Peninsula, while Newfoundland lies some 250 miles eastward across the gulf.

The Appalachians north of Gaspé Bay reach heights somewhat above 1000 feet. Northwest of Grande Grève (south of Cap des Rosiers) Mt. St. Alban has an elevation of 930 feet. The ridge line drops steeply eastward to 150 feet in the portage behind Grande Grève, then rises to 713 feet back of Indian Cove, and sinks again to 190 feet at Cape Gaspé (Fig. 4). On the northeast the ridge has been eroded by the sea so as to present a continuous face of cliffs. These are notched at frequent intervals, the deepest notch being at the Grande Grève portage where the actual cliff is reduced to a mere 10 feet of rocky slope, scalable in dry weather. A coulée beginning in the highlands south of Mt. St. Alban extends throughout the length of the Forillon. The ridge thus left along the bay side is lower than the one bordering the gulf (Pl. 2, *B*). Its northern slope, though shorter and steeper than

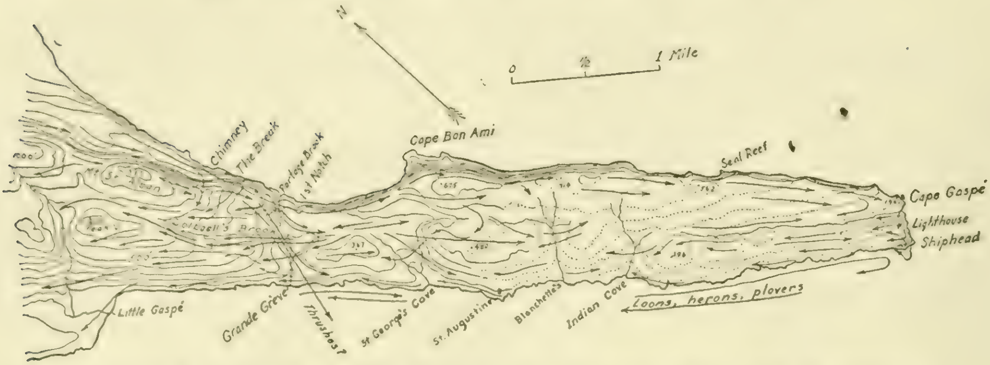

N
0
½
1 Mile
Cape Bon Ami
Seal Reef
Cape Gaspé
Lighthouse
Shiphead
Chimney
The Break
Portage Brook
1st Notch
Mt St Alban
O'Neil's Brook
Little Gaspé
Grande Grève
Thrushes
St George's Cove
St. Augustine
Blanchette's
Indian Cove
Loons, herons, plovers
675
562
400
396
347

Figure 4. Contour map of the Forillon showing chief lines of flight.

the southern, is precipitous only for one-half mile near the outer end. At its terminus, known as Shiphead, a lighthouse stands at the brink of the cliff, 350 feet above the sea (Pl. 2, *A*).

At Grande Grève, St. George's Cove, Blanchette's, and Indian Cove, the southern ridge is cut by small streams that drain the coulée (Fig. 4). Another stream drops 40 feet over the terminal cliff, and a brook flows from the northern end of the portage. Near the center of the little peninsula a high saddle occupied by a sphagnum bog crosses the coulée between St. George's and Indian coves.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge with gratitude the help so freely given by several people, enabling me to carry out these studies. Permission to enter the Gaspé Provincial Park on several occasions was granted by Dr. Camille-Eugène Pouliot, Ministre de la Chasse et des Pêcheries, and Mr. F. de B. Gourdeau of the Services des Parcs. Of the same organization Messrs. Steven MacWhirter, Césare Fortin, and several guardians were generous hosts and guides. Officers of the Cascapedia Mining and Trading Company also provided hospitality. Through Dr. I. W. Jones, Chief of the Geological Surveys Branch, Department of Mines, Quebec, and Dr. F. J. Alcock, Chief Curator, National Museum of Canada, important maps and publications were procured. Mr. R. Charles Lindsay placed at my disposal not only his own, but several camps about the peninsula belonging to the Quebec Fisheries Service. Meteorological data from United States Weather Bureau Stations in New England and Canada were made available by Mr. John B. Underwood of the U. S. Meteorological Service. Thanks are returned to Mildred Porter Cloud and to Clara Mae LeVene for typing and editing the manuscript, and for helpful criticism.

I am grateful to Professor John S. Nicholas, Chairman of the Zoological Department in Yale University, to Professor Richard S. Lull and Professor Albert E. Parr, former Directors of the Peabody Museum, and to Professor

Carl O. Dunbar, the present Director, for granting me extension of time, as well as funds for the field work, and freedom to work up the results. Special thanks are due Dr. Dunbar for accepting this paper as a Bulletin of the Peabody Museum, and for his part in directing it through the press.

PROBLEMS OF MIGRATION

Looking at the Gaspé Peninsula as a whole in relation to bird migration, a number of questions arise. Does it receive many migrants from the north, and where do they land? What paths on the peninsula do they follow, coastal or overland? If overland, do they cross southward along a broad front, or do most of them, as narrow-front migrants, follow north-south valley routes? Several of the latter appear attractive (Figs. 2 and 3). Most clearly marked is that through which the Ste. Anne River nearly connects with the Little Cascapedia between the highest mountains of the Shickshocks—Mt. Albert and Mt. Lyall on the west, and Tabletop with its outliers on the east. Indeed, the geological studies of Alcock (1926) have shown that by stream piracy the Ste. Anne has acquired a part of the Little Cascapedia's former headwaters in the region now marked by Lake Ste. Anne. My data appear under the section devoted to Ste. Anne.

A similar path, yet to be investigated, lies still farther west, whereby migrants might ascend Coté Creek, a western tributary of the Ste. Anne, and continue through the pass into the watershed of the Cascapedia (Coleman, 1922). The latter could also be reached via the Cap Chat River through the gap east of Mt. Bayfield.

Another low divide leads from the Madeleine Valley and York Lake. Frequent observations over several years have failed to disclose such use of this avenue. But through a pass west of Mt. King from the Madeleine to the York valleys, migration of warblers and thrushes has been observed. Significantly, from its bend near Whitehouse (Fig. 2. WH) the York Valley extends both southward (upstream) for 8 miles and eastward (downstream).

Although less apparent on most maps, another southerly route leads up the Petite-Vallée and descends a tributary of the Dartmouth. Its juncture with the latter at a sharp bend gives access to the Dartmouth's southeasterly trending lower valley on the one hand, and, on the other, to the narrow upper valley that rises for 20 miles almost directly southward to its source in Dartmouth Lake. Merely a low saddle intervenes between the lake and the York Valley. Indeed, there are here three similar notches through the divide, very conspicuous from the York River road (Pl. 1, *C*).

No other important avenues lead through the mountains from the north shore until we reach Fox River, then Griffin Cove, and finally the portage across the base of the Forillon to Grande Grève. It was in relation to the latter that most of my studies were carried on during the period 1935–1946.

Do birds breeding on the peninsula generally follow similar paths? Within a species, does its Gaspé population migrate before representatives from farther north, at the same time, or later? Do birds breeding north of the St. Lawrence migrate across the Gulf of St. Lawrence, only a few of them touching the eastern Gaspé coast? Is it possible that birds from Newfoundland occasionally reach Gaspé?

During the progress of field work other questions arose. When it became evident that thrushes migrate down valleys which radiate from the higher mountains, and that they descend even those with a northerly trend, consideration of possible directive stimuli was demanded. What, beyond instinct, oriented these birds? Early in the studies it became apparent that something more than the method of trial and error was concerned.

When do thrushes begin and terminate their flights? Are they able to descend to the ground during the night, or once in flight must they continue until dawn? Do some of them continue after dawn? Why do they utter flight calls oftener just before dawn than during the night, even more often than in the hours between dusk and 10:00 P.M.? What proportion of those flying over a given area pass silently? Are others migrating so high above the ground as to be inaudible? How many pass southward through mountain passes? In this paper these and other questions receive at least partial answers.

PREVIOUS WORK

From September 20, 1923, to the middle of August 1924, John B. Demille (1926) lived on the headwaters of the Madeleine River southeast of the Tabletop Mountains. He studied the distribution and behavior of birds in this north-central part of Gaspé, and made monthly visits to Mont Louis. One trip around the coast to Port Daniel provided opportunities for observation at Gaspé Basin, Percé, and other points. He reports little evidence of migration across the peninsula, concluding rather that most resident species, at least, follow the coast, and ascend the rivers southward from the northern Gaspé coast in the spring.

Brewster (1883), Townsend (1920, 1923), Lewis (1930, 1939), Taverner (1934), and others who have collected and studied birds of this region, have had few opportunities to gather information concerning migration of land birds. Since such species as gannets, cormorants, gulls, guillemots, murres, and puffins which nest along the shore cliffs obtain their food chiefly or entirely from the sea, their migrations are wholly coastwise. So much has been written of the astounding rookeries on Percé Rock and Bonaventure Island near by that consideration of them here would be but repetition.

My own observations of migration by the red-breasted nüthatch (*Sitta canadensis*) tend to show that this species, probably exceptional, enters the Forillon in large numbers from Anticosti (Ball, 1947). Although as many as 1188 were seen leaving the Forillon on a single morning, extremely few were ever observed entering from the west. Curiously enough, rather than cross Gaspé Bay, 5 miles or less in width, these little birds all passed northwestward to the mouth of the Dartmouth River.

It was pointed out in my 1947 paper that the same path out of the Forillon was followed not only by warblers and other passerines but by numerous hawks as well. Other references to migrants appear in earlier annotated lists (Ball, 1938, 1943).

OBSERVATIONS

MIGRATION OF SEA BIRDS

While the author has made no special attempt to trace the migration of sea birds in Gaspé, it is believed to be wholly coastwise. This is certainly true of cormorants (*Phalacrocorax*). Several colonies of *P. auritus* breed on cliffs from Cap des Rosiers to Cape Gaspé on the northern shore of the Forillon. Others occupy sites scattered along the south shore of Gaspé Bay. Best known at the end of the peninsula is the colony on Percé Rock. At Black Cape on the Chaleur Bay coast, the rookery is exceptional in that the birds nest in trees.

Eight years' residence on the Forillon has brought acquaintance with the daily behavior of cormorants. Through the notch at Grande Grève many of those nesting on the northern cliffs pass to and from their feeding grounds at the head of Gaspé Bay. None turn eastward toward its mouth as they reach the bay shore of the Forillon at the end of their short passage through the portage. Invariably they turn to the right up the bay. On their return these birds unerringly fly home through the same gap. They are seldom seen during the summer in groups of more than 12 or 15.

Very striking, therefore, was the behavior of a flock of 30 cormorants that passed in perfect V-formation southward over my observation post behind Grande Grève on August 31, 1939. Instead of veering right as usual, the leader steered more to the left, at an elevation of 100 feet above that of a normal foraging flight. Upon reaching the bay the line of flight was shifted still farther to the left and a course set for Percé Rock, just visible beyond the southeastern and outer limit of the bay. Through binoculars the large black flock was followed to the limit of visibility. When at last it dissolved into the distance, at least 3 miles down the bay, the course was still directly toward Percé.

That this flock had just set out on the fall migration down the coast was confirmed by inspection of the cliffs at Cap des Rosiers; these western nesting grounds were forsaken. What course had been followed by the other 150 birds of this colony? Unobserved, it may have been the same as the flight that I had been fortunate enough to witness; or it may have been along the cliffs to Cape Gaspé.

Again, on September 3, 1946, a file of 14 cormorants followed the same path through the portage and on toward Percé. They were in sight from 6:32 until 6:40 A.M. Gauging their speed at 30 miles per hour, the birds had covered 4 miles when they became invisible through the binoculars.

It would be interesting to know whether cormorants from the Forillon colonies stop at Percé and thus temporarily augment that population, or whether they continue as a unit down the coast of Gaspé to New Brunswick. No autumn increase in numbers of cormorants about Gaspé Bay has been noted. Doubtless those from Anticosti and the Labrador coast cross the gulf east of Gaspé.

Of the other species of sea birds that breed on the Forillon, namely razor-billed auks, murres, black guillemots, and herring gulls, none has been observed in migration. However, their ranks become much thinned by November 1; supposedly they, too, pass on down the coast.

The American eider (*Somateria mollissima dresseri*) which nests sparsely along the outer Gaspé coast is joined in October by small numbers of scoters (*Melanitta* and *Oidemia*). Their avenues of approach are probably south and southwest across the St. Lawrence River and the gulf. Since few of these ducks are seen near the head of Gaspé Bay, their southward flights are assumed to be coastwise.

On the other hand some 150 American golden-eyes (*Bucephala clangula americana*) and 1000 black ducks (*Anas rubripes*) gather at the mouths of the Dartmouth, York, and St. John rivers each fall. These breed about the numerous ponds and lakes of the interior. Large flocks of black ducks daily pass to and fro, a distance of 2 miles through L'Anse-aux-Cousins Portage, across the point of land that separates the mouths of the Dartmouth and York rivers. In doing so, these ducks fly a generally north and south line through a valley whose highest floor elevation exceeds 200 feet. Since this species migrates either by day or by night, the fact that none of the hunters about Gaspé seem to have witnessed a migratory flight would indicate that the flocks frequenting the bay and estuaries during September and October pass southward at night. That the path is overland rather than coastwise would be expected from their migratory behavior elsewhere. Probably the golden-eyes, and the few green-winged teal and Canada geese that visit the river flats in autumn, also pass overland. Demille found geese and fresh-water ducks flying southward along the upper waters of Madeleine River near the center of the peninsula in the fall.

American mergansers (*Mergus merganser americanus*) are common in late summer and fall on the estuaries and even far up the rivers. Demille's surmise that the red-breasted merganser (*M. serrator*) migrates northward coastwise, and southward overland may be correct, although the bird flying south along the Madeleine River on October 21, 1923, if seen near his camp, would have been flying downstream, and might later have turned northward with the river. My only records of this species were made along the seaward cliffs of the Forillon.

MIGRATION OF SHORE BIRDS

Between late July and mid-October several species of shore birds visit the mud flats that are exposed at low tide in the estuaries about Gaspé Bay. Several small gravelly beaches and the more extensive ones at Peninsula, Sandy Beach, and Haldimand also attract them. Yellow-legs, chiefly *Totanus* *melanoleucus,* semipalmated plover (*Charadrius semipalmatus*), turnstones (*Arenaria interpres morinella*), sanderlings (*Crocethia alba*), and semipalmated sandpipers (*Ereunetes semipalmatus*) are oftenest seen, but never in large numbers. A dozen Hudsonian curlews (*Numenius phaeopus hudsonicus*) is about the limit to be expected at one time within the bay. In eight years of observation a pair of knots (*Calidris canutus rufus*) and one Hudsonian godwit (*Limosa haemastica*) have been encountered by the author. The only resident limicoline recorded is the spotted sandpiper (*Actitis macularia*).

Whenever seen in flight these birds have been close to shore, and probably follow it in migration. Excepting *Actitis,* none have been seen in the interior of the peninsula about the lakes and ponds. Demille's statement that solitary sandpipers "were to be found on practically every pond" seems not to be true of eastern Gaspé. His record of three black-bellied plover on Tabletop Mountain is our only inland record, and a very interesting one, for he saw them on September 28 and again on September 30. Presumably they were the same birds remaining to feed on their favorite berries, *Empetrum nigrum.* Again, one might assume that two migrant groups of birds had been attracted by this isolated bit of upland tundra as they passed southward over the peninsula.

MIGRATION OF LAND BIRDS

Inspection of a map of Gaspé and contiguous areas raises questions as to the direction likely to be taken by land birds which, due to birth or previous migration, find themselves near the northernmost limits of the peninsula. Will they fly southward overland, or along the coast? If the latter, will they pass east or west? Either path would soon direct them obliquely southward owing to the symmetrical sweep of the coast, on the one hand toward Cape Gaspé, and on the other, up the St. Lawrence Valley to the southwest.

Were the more direct route overland to be followed, the birds might be expected to take advantage of any north-south river valleys that would protect them or serve as landmarks. As Demille (1926) has pointed out, one such avenue is provided by the Mont Louis River and the north branch of the Madeleine leading into the south branch to Lake Madeleine, on toward the headwaters of the Bonaventure, and thence to Chaleur Bay. He found little evidence that passerines choose this short route. On the contrary his observations tend to show that they ascend Mont Louis River (southward) in spring and descend it in autumn; he concluded that the migration of passerines was coastal.

Another method of crossing the peninsula is by direct southward flight at heights from 4000 to 10,000 feet above sea level well above the highest mountains. Use of this stratum by geese is indicated by observations of hunters and woodsmen. The possibility that passerines likewise do so is discussed beyond (p. 165). That passerines indigenous to Gaspé ascend to this level will be shown unlikely.

HAWK MIGRATION

During early August (Aug. 7, 1941), the first migrant marsh hawks (*Circus hudsonius*) annually appear at Grande Grève on their way down the Forillon. Their numbers, though never great, increase until about August 25, then gradually diminish. Most of them appear singly, or in small loose flocks, never more than 5 being in sight at once. Thus far all have been regarded as immature birds. Possibly a few females were included, but there were no gray adult males.

Since these hawks progressed but slowly, swinging widely from side to side in search of food, often along the bay slope, they were easily followed in an automobile on the road. Some took 20 minutes, others as long as two hours, but all eventually reached the clearing at the Lighthouse. Here some hunted for an hour or so, perching now and then on fence posts within a few feet of the terminal cliff. Sooner or later every one worked back to the northwest whence he had come. The greatest number seen at Shiphead was 10 in two hours on August 14, 1941.

Not a few marsh hawks were seen over the coulée and the northern ridge where occasional clearings afforded good hunting. One of the largest was the open plateau above Seal Reef (Fig. 4). When these hawks reached the end of the Forillon at Cape Gaspé, some turned back up the coulée or the north ridge, others soared upward and then southward to the Lighthouse clearing. Later all these flew northwestward, usually over the fields and pastures along the bay slope. At the tip of this narrow peninsula each one seemed interested only in searching for food, not at all in crossing the bay, 6 miles wide at its mouth. Only a single hawk was seen crossing anywhere; a marsh hawk flew from Peninsula to Lobster Point, scarcely 2 miles away (August 17, 1940).

A few days later several other species of hawks could be expected. Pigeon hawks (*Falco columbarius*), sharp-shinned hawks (*Accipiter velox*), and goshawks (*Accipiter atricapillus*) appeared respectively on August 12, 13, and 14 in 1941, and reached their height about August 28 when 46 goshawks were recorded. On that date 52 broad-winged (*Buteo platypterus*) and 3 red-tailed hawks (*B. jamaicensis borealis*) passed through the Forillon.

In flight the first three species above mentioned are quite direct. I have seen a goshawk, for instance, glide from the top of St. Alban across the portage into the coulée behind St. George's Cove, hardly veering in a mile's flight. Two pigeon hawks from the western highlands passed over Roberts Knoll, alighting in spruce tops every 100 yards or so, but holding a straight course. The sharp-shinned hawks also proceed directly when not distracted by prey.

The buteos, on the other hand, are usually seen soaring and wheeling along well above the ground and forests. Seldom do they descend to a perch. This is true even at the end of the Forillon in the case of the red-tails; all soar back up the Forillon. The broad-wings often descend into the woods, probably in search of the abundant red squirrels. These gentle hawks in turn become the prey of goshawks. The remains of several have been found in the forest, feathers strewn over the ground for many yards, with only a leg or part of the skull intermingled. In the conspicuous hawk-flight of August 28, 1941, for example, both species were abundant near Cape Gaspé. During an hour in the forest west of the Lighthouse clearing I counted 22 goshawks and over 50 broad-wings. At least 3 of the latter were struck down.

To the long list of published incidents illustrating the voracity of these accipiters, the following experience may be added. After shooting 5 goshawks I laid them side by side on the ground beneath a spruce at the edge of the woods, rested the gun against the tree, and descended into the coulée to record migrants. Returning two hours later only one hawk remained. Since no foxes were known to frequent that vicinity the inference that cannibalism had been practiced by still other goshawks is probably correct.

Incidentally, after skinning the remaining hawk, a tender bird of the year, our family ate the flesh and found it superior to grouse. This leads to the statement of a striking fact; as in the case of the marsh hawk, every goshawk seen in Gaspé during 10 years of observation has been an immature bird. One may well wonder what route is followed by the adults. Certainly in years of heavy southward migration many of the latter reach southern New England.

In this connection it is interesting to find in "Records of New England Bird Life," volume 5, that 17 goshawks, including at least one adult, were recorded during October, November, and December 1941. These hawks accompanied the great incursion of snowy owls of which 4 or 5 were seen about Gaspé Bay. Equally arresting are the numbers of broad-wings—1520 between September 12 and 21, practically all of them in Massachusetts.

In Gaspé, on August 20, 1939, 71 red-tailed hawks passed eastward across the Indian Cove gap in the south ridge and on toward Shiphead. From a favorable location on the hilltop east of the village many of these grand birds were but a few feet above me as they soared past. During an hour spent there the procession was nearly continuous. As many as 10 could be counted at one time. Soon after disappearing toward Shiphead, each group returned westward. Seven marsh hawks, one sharp-shin, and one goshawk also passed down and back. The wind had been light to moderate and westerly during the six preceding days of high pressure; the 20th was almost wholly calm. Temperature ranged from 14.5° to 17.5°C.

The 24th was characterized by a good flight of 115 hawks, chiefly red-tailed and broad-winged. Clear, warm weather with very light northwesterly wind presented a striking contrast with the preceding day when the wind at dawn blew lightly from the east and the temperature was 21°C., highest of the summer. The 22d had been calm with an occasional light westerly breeze. Therefore these hawks apparently had not been drifted into the peninsula by air currents.

Another notable migration of buteos occurred on the Forillon August 27. From the same hill east of Indian Cove 130 red-tailed and 5 broad-winged hawks were seen wheeling eastward between 11:00 A.M. and 1:30 P.M. Apparently these, like those of the preceding week, turned back immediately upon reaching Shiphead, for each group soon returned over my lookout. Through binoculars they were visible for a mile or more. In order to determine their behavior at Cape Gaspé I occupied that post from 1:00 to 2:00 P.M. Although the flight had passed its peak, a few groups of buteos visited the point, only to soar back up the peninsula as usual. On this morning the tip of the Forillon was visited also by 11 sharp-shinned hawks, one goshawk, and one marsh hawk.

With some confidence one might regard wind as partly responsible for this largest flight of hawks, for it was observed on the fourth day of westerly winds. That of the preceding days was south-southwest, 5 to 10 m.p.h., and on the morning of the flight, 8 to 15 m.p.h. At the same time it should be recalled that these hawks all flew back up the Forillon after reaching its tip. Although they may have drifted into the Forillon with the wind, they, of course, had no difficulty in returning against it.

In view of the statement by Wetmore (1927, p. 80) that in migration "red-tailed and rough-legged hawks in eastern North America travel singly, out in the middle west, may be found in large flocks," it may prove that these concentrations of red-tails in Gaspé find their way up the St. Lawrence to the Great Lakes and thence southward into the mid-west.

With these Gaspé migrants in mind, reference is again made to the appearance in New England of buteonine hawks from the north in 1939 (Bull. New Eng. Bird Life, 3, no. 9:3). On September 3 the first 9 broad-wings were recorded at Jaffrey, New Hampshire. The 12th brought 42 to Waltham and 38 to Sudbury in eastern Massachusetts. At Mt. Tom's famous observation cliffs near Northampton, hawks of this species descending the Connecticut Valley were counted as follows: 3 on September 15, 32 the 16th, 157 the 17th, 1941 the 18th, 1250 the 19th, and 830^{+} the 21st. Others were noted in many New England localities in early September. Of red-tailed hawks few appeared in September, and only 78 in October. Possibly among the broad-wings may have been some of those that visited the Forillon in August.

In other parts of Gaspé no concentrations of hawks have been recorded. Marsh hawks appear singly here and there, chiefly over the broader fields along the St. Lawrence shore. Only one record of this species was made inland, a bird flying westward over York Lake August 14, 1941. However, Demille reports individuals seen frequently over the interior farther west during the "summer months." Goshawks also have been restricted to the coast. This species has not yet been recorded nesting in the Gaspé. But a few red-tailed hawks do so and have been seen far up the York and Ste. Anne rivers in September. None of these gave a hint as to what direction might be followed in leaving the peninsula.

Along the south shore of Gaspé Bay migrating hawks are seldom seen. In five years' residence at Sandy Beach fewer than 20 hawks have been recorded. All of them have appeared singly; nothing like the "flights" of buteos and accipiters that are so impressive on the Forillon has come to my attention. One of the challenging problems is subsequent behavior of hawks that become concentrated on the Forillon. Little evidence is at hand that numbers of hawks, like passerines, cross the Dartmouth estuary. Nor have they appeared in any of the major valleys. Therefore, it is surmised that the majority of buteos follow this well known tendency to migrate along ridges where up-drafts are available. Although no "flights" of this sort through the interior of the peninsula have been recorded, a few individual red-tails are seen each summer near the tops of the mountains north of the York River, and about York Lake. Possibly some of these are migrants.

Several pairs of sparrow hawks annually rear families in the burned or lumbered areas along the York and St. John rivers. During July and early August one sees them hunting daily. By the middle of September they leave, but I have been unable to trace their migration routes. In late September 1948, there seemed to be some evidence of drift westward up the York Valley in a locality 40 miles inland. But the movement was extremely slow, and it may have been a coincidence that three families, seen in succession, were moving westward; they may merely have been foraging, for late in the season a given family hunts over widening territory. Possibly these birds are attracted southward over extensive "burns" around the headwaters of the St. John and Bonaventure rivers. Negative evidence of up-stream migration lies in the lack of records in the lower parts of the York and St. John valleys, and along the south shore of Gaspé Bay; if all the sparrow hawks living in these two valleys were to descend to the bay at the end of the season there should be a total of more than 100 birds, some of which should have come to my attention.

Of the hawks seen along the St. Lawrence slope of the peninsula the numbers have been too small to establish unmistakable trends. Individual red-tails and goshawks have been recorded passing both eastward and westward along the high slope behind Fox River, and again at Griffin Cove, Grand Etang, and Ste. Anne des Monts. The majority of marsh hawks have been working eastward, particularly between Fox River and Cap des Rosiers. I have never detected a hawk passing into the Forillon at the Break, nor from the lowlands behind Cap des Rosiers to the highlands west of Grande Grève. But they certainly reach the top of St. Alban, probably ascending the northern escarpment farther west. Large flocks of crows have been seen thus ascending eastward into the mountains where the highroad from Cap des Rosiers enters.

PASSERINE MIGRATION ON THE FORILLON

From the vicinity of Madeleine the north shore of the Gaspé Peninsula curves very slightly to the south of east through a 60-mile arc to Cap des Rosiers. Thence the narrow finger of the Forillon points directly southeast across the mouth of Gaspé Bay toward Percé. From Cape Gaspé birds can easily see Point St. Peter, only 8 miles away, at the end of the bay's southern shore. One might expect migrants from the northwest to be funneled into the Forillon, and to continue across the bay and on down the coast.

The discovery during a brief visit in late August 1935, that small birds were flying out of the Forillon in exactly the opposite direction led to the studies reported here. At that time these birds were supposed to have entered the little peninsula from Anticosti or perhaps even from Newfoundland, and accordingly were continuing their journey westward along the coast. But in 1936, it was evident that the trial and error method was being used, not only by passerines but even by strong flying hawks. Possibly the soaring buteonines were guided by "thermals," ascending columns of air warmed by the Forillon.

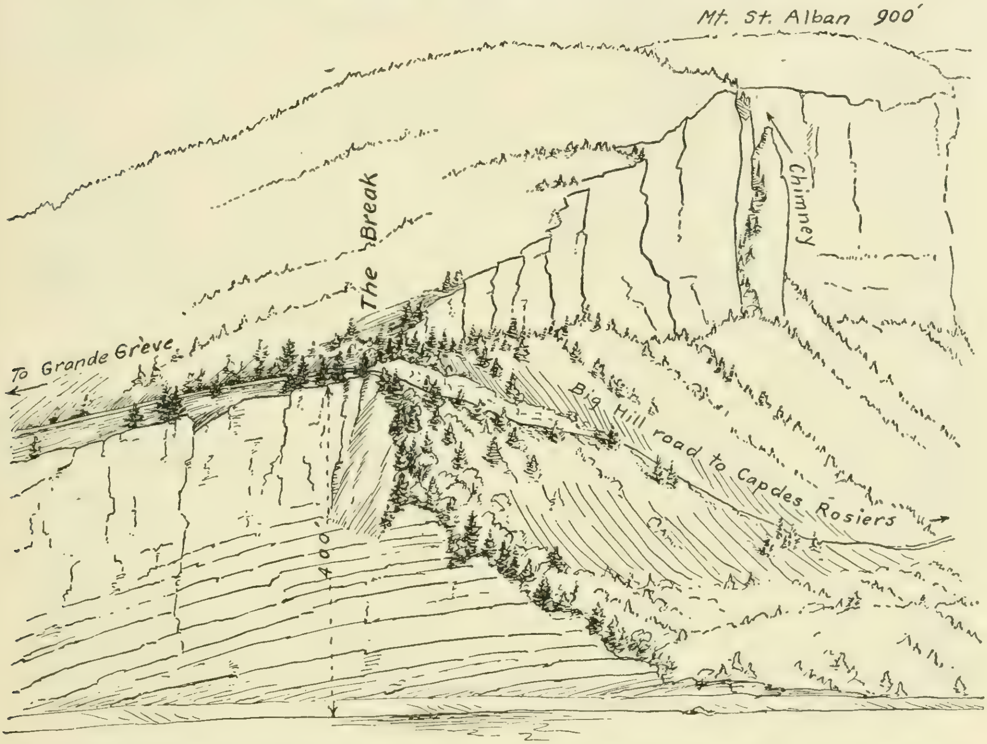


Figure 5. The "Break," where the road from Grande Grève pitches down the "Big Hill" toward Cap des Rosiers.

Beneath the cliffs of St. Alban a talus slope, chiefly forested, descends to the flat lowlands of Cap des Rosiers, a mile or more in width. From midsummer to late fall migrants may be seen daily passing from tree to tree along fence rows, or crossing fields from one wood lot to another southeastward toward St. Alban. Having reached the talus slope they continue toward the Forillon, concentrating either along the base of the talus or along its top at the foot of the cliffs. For nearly a mile these cliffs present an unbroken face. It is interrupted by a deep notch called "The Chimney" (Pl. 1, *A*).

A considerable number of migrants ascend through this notch, thus reaching the crest of the northern ridge about midway in its descent from the top of St. Alban to the portage. Many of these birds turn back to the northwest in the forest margin above the cliffs, or cross into the coulée that leads back into the highlands north of Gaspé Bay. It may be pointed out that upon emerging at the top of the Chimney (720 ft., elev.) they have a clear view down the Forillon to its termination in the gulf, and hence avoid it.

The talus slope ends at a little break in the ridge, hereafter referred to as the "Break," where the steep cart road from Cap des Rosiers passes suddenly over into Grande Grève (Fig. 5). East of the Break the cliffs continue, beginning with a sheer 400-foot drop to the eastern end of a little gravel beach bordering the cove.

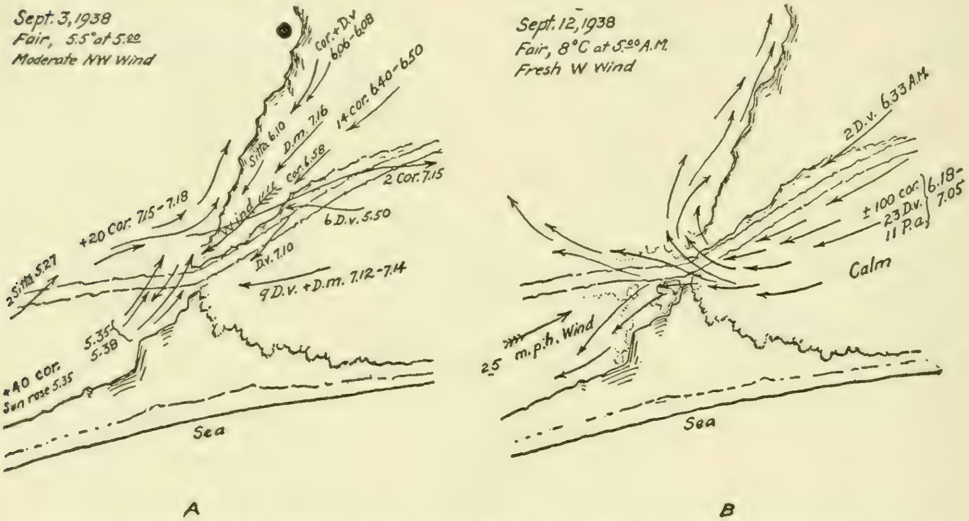

Sept. 3, 1938
Fair, 5.5° at 5.00
Moderate NW Wind
Cor. + D.v. 6.06-6.08
14 cor. 6.40-6.50
Sitta 6.10
D.m. 7.16
Cor. 6.58
2 Cor. 7.15
Wind
+20 Cor. 7.15-7.18
6 D.v. 5.50
D.v. 7.10
2 Sitta 5.27
9 D.v. + D.m. 7.12-7.14
5.35
5.38
+40 cor.
Sun rose 5.35
Sea
A
Sept. 12, 1938
Fair, 8°C at 5.00 A.M.
Fresh W Wind
2 D.v. 6.33 A.M.
± 100 cor.
23 D.v.
11 P.a.
6.18-7.05
Calm
25 m.p.h. Wind
Sea
B

Figure 6. *A.* Paths of migrants recorded at the Break on a morning when the wind was blowing from the northwest at 15–20 m.p.h.; *B.* In a 25–30 m.p.h. west wind. Cor. = *Dendroica coronata,* D.m. = *D. magnolia,* D.v. = *D. virens,* P.a. = *Parus atricapillus,* Sitta = *S. canadensis.*

Those migrants that pass the foot of the Chimney continue among or above the trees at the top of the talus to emerge at the Break. Others farther down the slope either follow the road upward, or, upon reaching the steep rock slide which terminates the base of the talus, ascend to the Break.

At this strategically located point daily observations were made for several weeks each year from 1936 to 1946. Figures 4, 6*A*, and 6*B* show the paths of birds at this point.

It will be noted that while some turn back at the Chimney others continue into the Forillon. Occasionally a few migrants fly eastward along the cliff face below the Break, doubtless entering the Forillon at the northern outlet of the portage.

Many attempts were made to determine the course of nocturnal migration, but aside from shore birds and thrushes, with little success; the notes of warblers, sparrows, and other passerines were seldom detected. Thrush calls were chiefly noted from the southern ridge behind my home at Grande Grève. Most of the birds came from St. Alban or the head of the coulée in the western highlands, rarely along the bay slope of the south ridge.

Visits to the Break during the evening hours (8:00–11:00 P.M.) yielded but scanty and indecisive data. However, the latter end of the night (3:00 A.M. till dawn) proved more satisfactory. Good evidence that thrushes enter the Forillon was obtained on two occasions, September 29, 1940, and September 15, 1941.

Of those entering at night some certainly appear to return through Grande Grève on their way northwest up the bay shore; for on several occasions, having noted the southeastward passage of a group of thrushes, a group similar in number of voices has flown up the shore about half an hour later. At a flight speed of 25 miles per hour the round trip of 9 miles could have been covered in 22 minutes. Doubtless at night, as observed in diurnal migrants, some moments of indecision would be spent near Cape Gaspé.

Migration into the Forillon

It has been stated above that warblers and other passerines enter the base of the Forillon at the Break, where the Cape Road crosses the northern ridge. Myrtle warblers have been seen higher on St. Alban's cliff margin working their way toward the Break. Below on the Cape Road others filter through the woods and along the edges of little clearings. Eastbound migrants have been noted more often at Roberts Knoll on the southern ridge (Fig. 7). On mornings of heavy migration from the Forillon westward, a mere half-dozen warblers may be found passing in the opposite direction. The tendency of siskins, redpolls, crossbills, and to a lesser extent, whitethroats and juncos to associate in flocks increases the numerical value of any one observation. In small numbers purple finches pass in and out.

In another paper I have described the behavior of red-breasted nuthatches in their flights over Roberts Knoll (Ball, 1947). Warblers in like manner accumulate in the trees at the west end of Gavey's Ridge before launching themselves into the air over the pasture. Some skim the ground, others mount 100 feet above it. But nearly all alight in the conifers at the west side of the pasture to continue through the trees.

On several occasions I have seen birds meet one another in flight over the Knoll and at other points along the Forillon. This happens among trees as well, especially along the top of St. Alban's cliffs. In most instances these birds pay little attention to one another; each individual or group continues on its way. Now and then a warbler, meeting a robin in flight, has been seen to swerve toward the latter or even to turn and follow it for a short distance, then to resume its former course.

Even among individuals of the same species I have seen little evidence of one bird being influenced to join another in reverse. All that usually occurs is that one swoops, the other dodges, perhaps circles, and then each returns to its original path. In these instances the participants have been myrtle warblers. In a few cases warblers of different species have met thus over Roberts Knoll, or at Indian Cove.

Perhaps the most impressive meeting and passing of passerines in trees has been along the terminal cliff edge between the Lighthouse and Shiphead Point. Here mixed bands of warblers pass each other within the same tree, some ascending, the others descending. My first experience of this sort led to the assumption that these birds were confused upon finding themselves at the tip of the peninsula, but subsequent observations in other locations along the shores of the bay have led to the conclusion that the birds merely meet and pass, attracted more strongly by what lies ahead than by other birds moving toward an area which the first have just left.

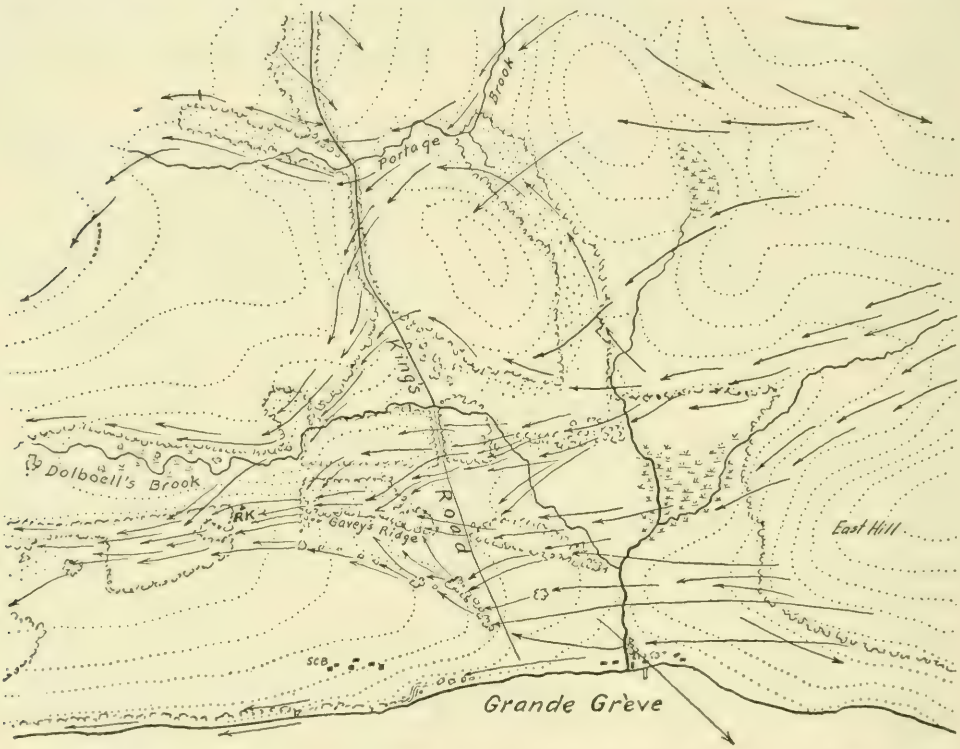


Figure 7. Principal fly-lines about Grande Grève, chiefly of migrants leaving the Forillon. RK—Roberts Knoll.

The behavior noted above gives no evidence that one bird in any way communicates to another information that it has already visited and departed from a locality toward which the second is flying. Each seems to be under the necessity of discovering Shiphead for itself, along with the water hazards involved.

Another avenue along which migrants enter the Forillon leads from Little Gaspé along the top of the bay cliffs. The slope above is forested as far as the western edge of the Grande Grève settlement. There the fields gradually restrict the woodland to a mere row of trees at the mouth of Dolboell's Brook. Here the birds become concentrated and are easily observed. However, fewer migrants use this route than the one along the top of the ridge past Roberts Knoll.

From the highlands west of Grande Grève a more spectacular entry of the Forillon is often exhibited by such birds as hawks, crows, robins, and white-winged crossbills. In long glides or dashes they descend to the beach, the fields, the forest behind Grande Grève, and even to the heights farther down the peninsula. For example, on the morning of October 11, 1940, from high on the slope of St. Alban a flock of 24 robins in loose formation passed over Grande Grève and disappeared toward St. George's Cove. Half an hour later 22 others dropped down from the western highland into the pasture beside Grande Grève swamp.

Beneath the cliffs at Grande Grève shore birds pass infrequently down the Forillon sometimes stopping briefly at the tiny beaches of gravel and cobblestones. As far as observed they, too, return up the bay rather than cross it. This seems true at night as well as in daylight. In September the calls of semipalmated plover (*Charadrius semipalmatus*) are heard at night passing down the bay. Within an hour the same number of voices may return westward. Three night herons were heard passing down and back on the night of September 13, 1940.

Only two groups of shore birds have been recorded passing from the St. Lawrence Gulf to Gaspé Bay through the Grande Grève Portage, one group containing 8 Hudsonian curlews (*Numenius phaeopus hudsonicus*), the other 3 semipalmated plovers. A number of individual great blue herons (*Ardea herodias*) have used this gap. One notable example continued directly across the bay toward L'Anse à Brillant, the only large bird other than sea birds known to have done so.

As for migration across the gulf from Anticosti and the north shore, only negative evidence is available. Far more birds have been seen leaving the Forillon from its base and passing westward, than have been seen by day or heard at night entering at the Break, across the Cape Road, at Roberts Knoll, and along the bay shore. How many enter at night is but partially answered by such auditory records as have been obtained during long night vigils on the Cape Road and at Roberts Knoll. Aside from a score of thrushes, fewer fox sparrows, and the shore birds cited above, the record is extremely meager. I never succeeded in detecting, nocturnally, the flight calls of red-breasted nuthatches, yet more than 1000 have been seen passing westward during the first two hours after dawn on a single morning.

In the paper devoted to this species the belief was expressed that many of these little birds reach the Forillon from Anticosti. But neither nuthatches nor other passerines were ever actually seen to do so. Many hours were spent along the tops of the cliffs at the portage, at the highest points behind Indian Cove, at Seal Reef and Cape Gaspé. Numerous warblers, robins, and fringillids were seen moving along the cliff crest, but none actually making a landfall. Below on the southerly slope many little bands of passerines have been seen working downward from the top, as though they might recently have landed.

At the foot of the cliffs only Cap Bon Ami offers anything like a sea level landing place for passerines. There, at the widest part of the Forillon, low grassy bluffs rise behind the gravelly beach. Behind them, covered with bushes and trees, the slope rises almost precipitously to Bon Ami Heights. Trips to Cap Bon Ami by boat, and by foot from St. George's Cove, have yielded no evidence of small birds other than resident white-throats and vireos. Use of binoculars from the heights above—about 650 feet elevation—has been no more rewarding. Possibly all my attempts have been made at the wrong hours, which have included but two dawn periods; perhaps these small birds do land upon the Forillon by day. One may more reasonably conclude that they do so at night, for they are commonly regarded as nocturnal migrants.

One may, of course, regard this failure to detect entry into the Forillon over the gulf as due to flight above audible elevations by birds passing south over the peninsula in fair weather.

Supporting observations of actual entry of the Forillon at its base, as above recorded, are eastward movements at various localities in the mountains north of Gaspé Bay. Three highways cross them, as at La Rancelle Hill, the Griffin Cove, and the Fox River portages. At Cap-aux-Os a road leads to a gypsum quarry in one of the high notches. In all these high lookouts warblers in small numbers have been recorded drifting toward the Forillon. Along the bay shore and the St. Lawrence, others were occasionally seen in eastward flight. Indeed, as far west as Ste. Anne des Monts this has been possible. Mr. Gordon Snider at Fame Point, between L'Anse à Valleau and Grande Etang, was kind enough to make observations of passerines there. During migration he found the stronger movement to be eastward.

Night Crossing of Gaspé Bay

On but one night were passerines detected setting out over the bay at Grande Grève. At 4:45 A.M., September 15, 1941, a good flight of hermit and olive-backed thrushes was in progress. During the half-hour before dawn more than a hundred passed within earshot of the wharf. The flight calls indicated that they came from the Break and the western highlands. Most of them continued down the Forillon, but 8 birds at different times left the main course to curve back northwest along the shore. Between 4:47 and 5:17 A.M. 10 thrushes—pairs in two instances, the rest single—passed obliquely across the beach line and out over the bay. They maintained their course as far, at least, as their calls were audible. Whether they reached the south shore is, of course, unknown. They may have returned to the Forillon farther on. It should be recorded that 7 thrushes passed Grande Grève on their way northwest up the bay shore at 5:05, 5:12, 5:18, 5:20, and 5:46 A.M. They are believed to have been returning representatives of those earlier migrants toward Shiphead.

Because of the surf and other beach noises the studies of night calls of birds along shore were best conducted either from the slope 100 yards back of the beach line, or from a boat offshore. Both methods were used. No unmistakable records of nocturnal migration across the bay were obtained from a boat. Such calls as were heard indicated flight along shore. Nor was I successful in detecting from the water, either at night or by day, birds approaching the Forillon from Anticosti.

Passage down the Forillon

At the outset it may be stated that through the length of the peninsula passerines were much less often seen moving southeast than northwest. This is doubtless a corollary of the comparatively smaller number seen entering at the base of the Forillon, from the west, and it implies either undetected entry of some numbers there, or arrival from Anticosti across the Gulf of St. Lawrence.

In tracing migrants eastward from the Break, little difficulty was experienced for the first quarter-mile; through the trees along the cliff edge they could be seen and heard descending the slope. But when they reached the portage brook their ranks were apt to split, some turning south toward the central coulée along the edges of a small clearing bordering the brook, others following the northern cliff margin through the trees over the next hill into First notch (Fig. 4). At times it was possible to trace these still farther, especially if they were warblers, for the latter kept more consistently to the cliff margin than did sparrows. The latter were more often drawn through the notches to the southern slope of the northern ridge, where they were apt to become dissipated.

The trends of flight were best determined by occupying strategically placed observation posts, such as the top of a hill, partly cleared of forest, or a path in a valley along which an extended view between the trees was possible. Especially favorable was a station where such a path entered a clearing; migrants often concentrate along a forest margin.

A fine open hilltop is situated on the northern ridge just west of the Forillon's mid-section. On its northern face the cliff drops 690 feet to the gulf. Its steep inland slope is clothed with tall conifers except for the last 100 feet. From the top, therefore, one can see birds that may be moving in any direction. The majority of those observed here have been warblers passing eastward around this peak in the conifers. In October 1940 a flock of 7 tree sparrows (*Spizella arborea*) fed for half an hour in the grass and weeds, then flew east above the forest to the next hill, highest on the Forillon.

Farther on toward Cape Gaspé half an acre of wind-fallen timber litters the top of another little peak at the brink of the cliff. On one October morning this tangle of dead trunks and branches had attracted a small flock of juncos (*Junco hiemalis*) and white-throated sparrows (*Zonotrichia albicollis*). When disturbed they, too, dashed eastward into the standing forest. A few minutes later I overtook them in the succeeding notch where they had found a few square yards of grass at the cliff's edge. Again these birds flew eastward through the evergreens. On the next hilltop they were not in evidence, but a half hour later a somewhat larger group of the same two species was feeding and playfully dodging about on the very tip of Cape Gaspé. Here the firs and spruces suddenly give way to a bit of cow pasture about 150 feet wide that forms a belt along the terminal cliffs (Pl. 1, *B*). These fringillids slowly worked southward down the slope into the end of the coulée. Approaching darkness forbade tracing them farther.

Not only along the north ridge, but on the southern as well, passerines have been noted working eastward. Here more pastures and open fields provide feeding grounds for sparrows, while scattered stands of conifers and brush-patches support and protect warblers in transit.

It is significant that more eastbound warblers have been noted on this ridge in the outer half of the Forillon, east of Indian Cove. Probably these birds sift down into the coulée through notches in the northern ridge, and then through similar notches in the southern, thus adding to the relatively few seen entering the peninsula along the southern ridge at Grande Grève.

Behavior near Cape Gaspé

Plate 2, *A* and Plate 1, *B* show the topography and distribution of vegetation at the tip of the Forillon. Here the southern ridge is the higher and wider. From an elevation of 350 feet at the Lighthouse it slopes rather evenly to the southeasternmost point, known as Shiphead. Here the 50- to 70-foot cliffs bordering the bay join the terminal precipice. Mature conifers clothe the slope to its very edge. At the top a clearing, some 200 yards in depth from the outer end, serves the Lighthouse.

The northern slope, on the other hand, drops steeply, in places precipitously, to the coulée with its brook. It is forested throughout, except for a shelf at the end that has been cleared to provide two acres of pasture. From here a rocky path leads down to the terminal beach, skirting a pile of rough talus beneath the Lighthouse site.

Summarized in Figure 8 are the paths of passerines observed in migration at the end of the Forillon. The numbers of individuals that follow the various paths are suggested by the numbers of arrows. Some of the birds that descend the terminal slope at Cape Gaspé turn back up the coulée. Others ascend to the borders of the little pasture shelf, and thence through the trees and bushes to the top of the talus. Here they meet the terminal cliff face. Occasionally a warbler strikes out boldly in horizontal flight along this cliff, to alight in the trees bordering its southward-sloping edge. A few others turn back northwest along the northern slope, but the majority mount to the top of this slope where it meets the terminal cliff. For example, one morning as I stood in the northeast corner of the Lighthouse dooryard, every few moments a warbler or vireo appeared in the outermost bushes crowning the brow of the slope. Most of them then dashed southward past me along the open top of the cliff, alighting in the nearest young conifers at its edge where the south slope begins.

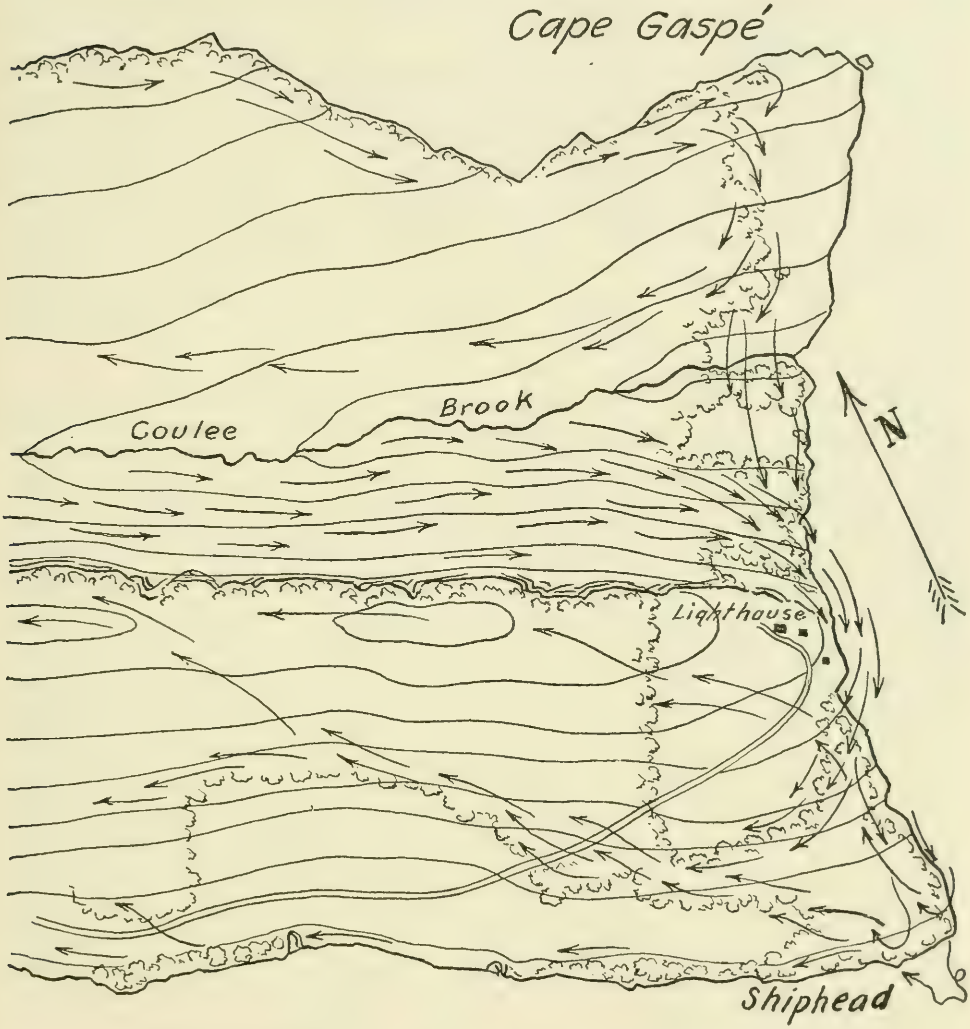


Figure 8. Paths of migrants at the end of the Forillon.

From this location the birds had a clear view of the slope to Shiphead, the gulf, the bay and its southern shore, less than 5½ miles distant at the nearest point near Bois Brulé. They could also see across the clearing to the edge of the forest west of the Lighthouse. Most of the birds chose to descend through the trees along the cliff margin to Shiphead Point. Others turned to the right along the lower edge of the clearing, but eventually also reached Shiphead. A third contingent, the smallest, flew northwest across the clearing. Similar behavior at the Lighthouse was observed on other occasions.

Passerines also reached Shiphead by following the southern slope of the Forillon above the bay. At times they were numerous in the trees fringing the low cliffs just northwest of the point, and in the trees at the base of the slope, bordering the last open hay field.

The greatest interest attaches to the behavior of birds that reach Shiphead, the most southeasterly point attainable on the Forillon. We have seen that they approach it from two directions. Those that descend the terminal cliff margin may linger, feeding in the trees about the point, or they may turn northwest immediately. All eventually do so, most of them making short flights from tree to tree.

Many hours spent in close study at the point itself revealed only one bit of evidence that a migrant warbler felt urged to fly southward across the mouth of the bay. On September 12, 1941, 2 myrtle warblers set out over the water from the top of a spruce standing at the brink of the bay cliff about 50 feet west of the point. The birds rapidly mounted as they flew out over the water. Furthermore, they dodged right and left as though feeling their way toward Bois Brulé directly across the bay. The wind was very light and westerly, therefore no hindrance to them. Nevertheless, at a point about 300 feet from shore they towered vertically, reaching an altitude above the water of some 200 feet. Then they suddenly veered back and downward to alight in trees 50 yards west of the starting point.

Migrants that approach Shiphead along the bay slope from the west seem to show no more confusion at the point than the others. All those observed turned left and mounted the slope through or above the trees. Most of them followed the terminal cliff edge to the trees bordering the Lighthouse grounds, and then turned northwest along the edges of the clearing. A few upon reaching Shiphead turned more sharply and worked back obliquely up the slope along the inner border of the lower field. This path was also followed by many of those birds that had reached Shiphead via the coulée and the terminal cliff. They could most readily be counted where the road to the Lighthouse ascends through the woods. Here, along the southwestern edge of the clearing, they were more concentrated in the trees.

As stated above, a relatively small proportion of migrants followed the edge of the cliffs along the bay shore. Of those which did so, a few were warblers, vireos, and other insectivorous forms that were attracted to trees. These were often isolated birches or spruces, but in some localities larger patches of mixed forest remained, as at the west end of Shiphead settlement, Indian Cove, St. Augustine, and the entire shore from the western end of Grande Grève to Little Gaspé. At times considerable concentrations, chiefly of myrtle warblers, gathered in these stands and could readily be followed through the trees. The numbers passing northwest exceeded those bound toward Shiphead.

Among the Fringillidae such ground-loving species as juncos, white-throated, white-crowned, tree, and fox sparrows, longspurs, and snow buntings, in their passage down and up the peninsula, kept for the most part to the more open bay slope of the southern ridge, feeding here and there in the fields and beside the road. On one notable occasion, October 18, 1940, among some 30 white-throated and tree sparrows, a single dickcissel (*Spiza americana*) was gathering weed seeds beside the road within half a mile of Shiphead. This straggler from the far west may have been the first representative of its species to attain so northeasterly a limit during the twentieth century.

Avoidance of Water

Other fringillids, the tree-loving white-winged crossbills, purple finches, siskins, and redpolls, followed the more wooded crest of the southern ridge behind the farmers' sloping fields, or kept to the northern ridge. No more striking demonstration of the passerine bond with land could be imagined than the sight and sound of 200 crossbills swiftly coursing southeast above the forest along the northern cliff line. As the flock reached Cape Gaspé it swiftly wheeled to the right and sped to the forest margin behind the Lighthouse at the crest of the southern ridge. After a few moments' work on the spruce cones the flock noisily returned northwestward above the trees toward Indian Cove. Similar behavior has been observed among flocks of siskins and redpolls. Snow buntings and Lapland longspurs are equally expressive of their fondness for the land. On more than one occasion in late October I have seen flocks alight in the clearing about the Lighthouse, feed for a while and then suddenly rise toward the northwest to disappear along the slope above the bay shore.

Only twice was any evidence shown that fringillids even considered flying over water toward the south shore, clearly visible across the bay. On October 21, 1940, a single snow bunting (*Plectrophenax nivalis*) left the ground behind the Lighthouse, flew horizontally bayward above the slope, towered sharply when it reached the water, and then continued across the bay toward Chien Blanc beyond eye-sight. More striking was the departure of a flock numbering about 20 pine siskins (*Spinus pinus*) on October 18, 1940. They had come down the Forillon along the top of the south ridge to the forest margin west of the Lighthouse. From there the group suddenly flew out above the slope and over the water. Their line of flight, to the limit of visibility, was obliquely southwest toward Seal Cove, somewhat up the bay. The darkest and most conspicuous mountains lay behind this village, and may have caught the attention of these birds once they were in the mood to cross.

Return up the Forillon

After leaving the vicinity of Shiphead all passerine migrants appear to follow either the forest margin near the top of the ridge behind the farmhouses, or the fringe of trees along the edge of the bay cliffs at the foot of the cultivated fields. This fringe is broken frequently, thus providing many convenient observation posts over which the birds must pass. At Indian Cove and St. George's Cove wide fields extend back along the streams into the coulée. Across these the warblers, vireos, chickadees, robins, and thrushes fly directly to trees at the west side of the gaps. It is indeed impressive to watch this procession from the brow of East Hill at Indian Cove. Yellow, myrtle, and black-throated green warblers, redstarts, red-eyed vireos, black-capped and Acadian chickadees, red-breasted nuthatches, and others filter out of the trees and launch themselves, individually or in small groups, westward over the fields and brook 200 feet below. Now and then an eastbound migrant, having spanned the gap, alights beside the observer. Similar behavior occurs at five lesser breaks in the southern ridge.

It has been stated above that some of the migrants that reach Cape Gaspé turn back up the coulée. Possibly others do so at various points along the north ridge. At any rate their numbers increase in the basal half of the Forillon. The presence of little groups of migrants working northwest high on the northern ridge behind Indian Cove, Blanchette's, and St. George's Cove may possibly represent arrivals from Anticosti. From such a height they can easily see that they are upon a tiny peninsula.

The most favorable location for watching migrants along the bay cliffs is a rocky point below St. Augustine church east of St. George's Cove. Here an acre of gently sloping land has been cleared to the edge of a 60-foot cliff which has been broken down by wave action so as to leave a deep cut east of the point. Across this cut migrants fly to and from trees farther down the shore. Some alight in a few scrubby spruces at the edge of the cliff; others pass overhead; while still others prefer the margin of the grove behind the point. The majority observed have been passing westward.

All properties on the Forillon front narrowly on the bay, but extend the full width of the peninsula. At least 30 of the 65 land-owners have cut paths that allow easy access through the woods; many of them reach the top of the northern ridge. At many points these trails open views above and ahead, across which birds can be seen in passage. In less than half an hour an observer can thus obtain a cross section of migration up and down the Forillon. Best of all for this purpose is the Cape Road that leads from Grande Grève part of the way through the portage and then northwest to the Break. From this noted lookout the road pitches down the Big Hill, too steep for automobiles, and over a lower hill beyond to Cap des Rosiers. The first quarter-mile back of Grande Grève gives an open view to the east across Dolboell's Brook and the fields and pastures that border it. On the west the shoulder of the southern ridge rises, partially wooded, toward the highlands west of the Forillon. The remainder of the road passes through forest, somewhat thinned here and there by cutters of stove-wood, thus providing extensive margins for hungry migrants. Several locations along this road were especially favorable for counting them.

Figure 7 shows the chief lines followed by migrants about Grande Grève. Roberts Knoll on top of the southern ridge behind my home was on the most commonly used line. Situated in open pasture between two wooded areas, and overlooking the coulée on the north and the bay slope on the south, a broad view was afforded across the base of the Forillon. In a previous paper (Ball, 1947) the behavior of nuthatches here was described. Warblers, vireos, titmice, kinglets, and others also favored this route from the Forillon to the highlands, and vice versa. The chief tributary of this fly-line leads from the north side of Grande Grève swamp along the margin of the forest to Gavey's Ridge. Another important line leads via the same ridge from a small patch of conifers on the west bank of Dolboell's Brook. These trees attracted migrants leaving East Hill. From the coulée north of the latter others reached the eastern edge of the swamp and either passed around it in the northern tributary or crossed to the conifers just mentioned. Still others that had approached Grande Grève along the bay slope crossed the gap to the southeastern end of a row of spruces in the angle at the juncture of the Cape Road with the main road along the shore. Working through these trees, they next either flew across a bit of pasture to the woods on Gavey's Ridge, or struck out over the rising field and pasture toward Roberts Knoll. Some of them occasionally dropped down into a small group of spruces beside the fence that bounds the Knoll on the east. Actually these trees stood at the intersection of a curved fence that leads from the row of the above-mentioned spruces near the road. At intervals along this fence stood a few birches or small conifers. Some migrants were attracted to this fence, alighting now and then on the rails or in the scattered trees. Eventually they reached the taller trees at the edge of Roberts Knoll.

From this same lookout could be seen, on the north bank of Dolboell's Brook, birds that had come from the north side of the swamp along the forest margin. With binoculars these migrants could be followed readily, above all in the early morning sunlight which shone brilliantly through their wings. Some of these crossed the coulée to the trees bordering Roberts Knoll on the west, alighting within a few feet of the observer.

The next most favorable station was on the Cape Road where it enters the forest behind Grande Grève. It was here that 1177 red-breasted nuthatches were counted in two hours on August 15, 1941. Many other passerines were recorded here.

Another important crossing place on this road is at the bridge over the portage brook farther to the north. Here a stump lot extends from the road toward St. Alban. Migrants filter up from the portage hollow along the brook, whose banks are marked with frequent clearings. The approach of migrants to the portage is chiefly along the coulée and the woods margin north of Grande Grève swamp, thence obliquely north on either side of the portage clearings. Others ascend the brook from the northern end of the portage, finding this, as it were, the line of least resistance between two highlands. After reaching the Cape Road they continue to the northwest along either side of the clearing. A very few have been noted crossing the road here in the opposite direction, on their way into the Forillon.

By no means all migrants passing out of the northern part of the portage follow the route just described. Some mount through the forest along the cliff edge to the Break, others fly farther inland so as to encounter the road on its last steep rise. Of these the road deflects a few to the Break, while the others continue upward through a chain of slashings over the southern shoulder of St. Alban into the coulée. Of those that find themselves at the Break the majority cross the road there and continue upward through the trees along the cliff edge. The others either drop with the road over the divide and work northwest along the talus slope, or turn left on a contour around the southern flank of St. Alban.

Wind as a factor on the Forillon

Two factors other than topography appear to enter into these birds' decision as to their course beyond the Break. First is the wind direction. A northwesterly current presents a strong head wind to any birds arriving in the trees on the seaward border of the road, and usually prevents their crossing northwest of here. On the other hand a more westerly wind results in a calm, due to the sheltering effect of the mountain, or to a southeasterly draft through the Break. Under the latter conditions warblers have been seen to pass northwest.

Figures 4, 6, *A* and *B* show configurations of wind and flight paths at the Break.

Sunlight as a factor on the Forillon

The second factor is light. Sunlight exerts a strong influence on birds, increasing their activity in many efforts, such as song and spontaneous flights. In migration, when a choice is presented, leading in the general direction of progress, they tend to follow the more intensely illuminated path. Such a choice is open to birds reaching the Break at sunrise and shortly afterward. As the sun emerges from the sea, the cliffs of St. Alban catch the first rays. With the strengthening of the light and its descent over the talus slope, a strong contrast with the shaded south side of the ridge is presented. It is at this hour that most birds choosing this route have been observed.

This attraction of the sunlit areas is regarded as a factor that holds to the trees bordering the brink of the cliffs on top of St. Alban most of the migrants that pass there, whether northwest or southeast. It also operates throughout the Forillon, especially on the southern ridge. When the early sun first strikes it, the steep northern slope alone is illuminated. At this time, the majority of migrants follow this slope, chiefly at its upper edge. As the sun mounts and the tips of conifers over the crest emerge into its brilliance the current of birds shifts also. But activity is restricted mainly to the tree tops.

From Roberts Knoll this effect of changing light is impressive. When the sun rises in mid-August the light streams through the portage gap, illuminating the trees on Gavey's Ridge and its extension through the stump-dotted pasture to the Knoll. The earliest migrants concentrate along this ridge. Westward the south ridge is still shaded by the sloping shoulder of St. Alban. From the portage they follow the forest margin to the Cape Road and then ascend to Gavey's Ridge. None follow the north bank of Dolboell's Brook farther west than the trees just emerging into the sun's rays. From there they cross the coulée to Gavey's Ridge.

As the sun continues to rise, this line of crossing moves farther up the valley. Through binoculars the observer on the Knoll can follow the birds moving through the conifers on the north bank of the coulée. With the shifting light the line of brilliant tips descends farther down the slope so that birds drop continually lower into the coulée. In the meantime those crossing to the southern ridge alight in trees successively lower on its northern slope as the line of crossing moves up the valley.

Again, migrants reaching the foot of Peak V (Fig. 4) early in the morning almost invariably turn left along its southern slope. Here the treetops are already sunlit, while the peak itself is still shaded by St. Alban (October 2, 1940). Later the northern slope of this hill comes into light and attracts a number of migrants to the right far into the head of the coulée (October 17 and 20, 1940).

Sunrise at Shiphead during the migration season is accompanied by similarly instructive behavior. With the first rays, warblers begin moving up through the conifers from Shiphead and pass in front of the Lighthouse to the sunlit trees along the crest of the north slope, and follow them northwestward. Later ones may pass behind the Lighthouse as the pasture there becomes illuminated. Presumably these earliest migrants have arrived in the spruce forest at Shiphead during the preceding night, possibly late on the previous day.

The appearance of so many migrants at the eastern side of Grande Grève swamp from one-half to two hours after sunrise is also traceable in part to the tendency of warblers, vireos, and nuthatches to follow northwestward the northern slope of the southern ridge as it becomes illuminated. Rather than fly the entire distance across the gap from the top of East Hill to the trees on Gavey's Ridge, they descend along the north flank of the hill, the later birds reaching even the bottom of the coulée. A similar topographical configuration and a similar behavior are to be observed at both Indian and St. George's coves. Since the northeastern ridge is higher there, the southeastern is shaded for a longer time, so that the respective groups of birds appear later in the valleys behind these settlements than at Grande Grève where the sun strikes earlier.

Many ground-dwelling fringillids—juncos, savannah sparrows, white-throated and song sparrows, preferring open land, pass northwestward along the sunny bay slope. Most such migrants have been observed in the late afternoon during October. Fox sparrows have more often been seen following the sunlit margin of the woods north of Grande Grève swamp. For example, more than 100 thus passed out of the Forillon on the afternoon of October 12, 1940. Farther west in the mountains back of Cap-aux-Os the attraction of this species to a sunny border was clearly illustrated on the afternoon of September 30, 1940. A narrow, trough-like glen extending westward, bordered by higher land on the north, was struck by sunlight entering over the little southern ridge. The whole area had been lumbered some years before and was covered by a thick growth of low mountain maple brush (*Acer spicatum*). Most of the leaves had fallen, exposing the ground to the birds' view. A dozen fox sparrows were feeding along westward on the sunny slope of the northern ridge in mid-afternoon. As the sun sank lower the shadow cast by the southern ridge crept higher, and with it the group of sparrows. During an hour they progressed about 300 feet and rose 20.

Another instance in which sunlight influenced migrants was noted between Indian and St. George's coves where the high saddle crosses the central coulée. At dawn myrtle and black-throated green warblers were slowly working eastward up the east branch of St. George's Brook. From their point of view among the trees all was in the shadow of the northeast ridge until they reached an open area of low bushes covering the western part of the swamp that occupies the divide. By this time the sun had risen high enough to brighten the eastern crest of a hilltop whose shaded portion they had just passed on their right. One by one 8 birds flew back and upward from the still darkened swamp to this sunlit part of the slope (Fig. 9). When I reached this area warblers of the same species were passing northwestward around the north shoulder of this hill—possibly some of the birds that had previously left the swamp. At any rate they soon flew farther northwestward 300 yards to a similarly lighted hill. Efforts to trace them farther were unsuccessful; but to an intermediate open knoll, just then coming into the sun's rays, a junco ascended from the still shaded valley. This bird and two other fringillids, at my approach, also flew to the higher sunlit slope that had previously attracted the warblers.

It could not be determined whether the warblers repeated their behavior shown on the first hill, passing around its north end, or whether they worked to the left through a notch toward the bay. Half an hour later warblers were passing westward above the brook where ledges on the north end of this hill were then in sunlight. These may also have turned

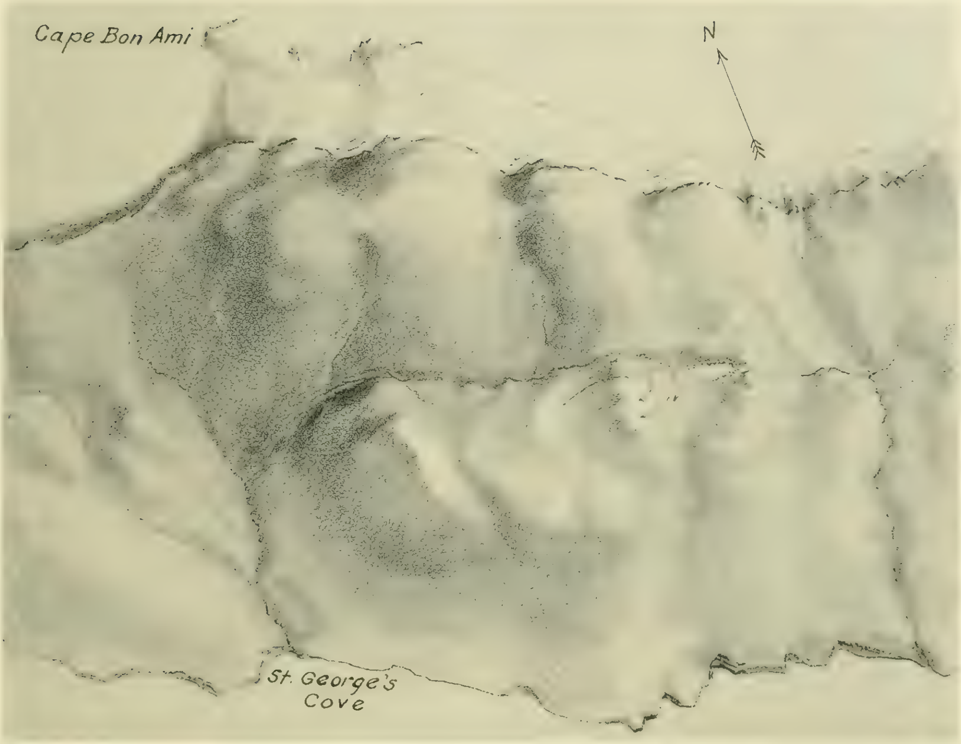

Cape Bon Ami
N
St. George's Cove

Figure 9. Sunlit slopes, attractive to birds soon after sunrise.

back in the coulée, or may have come up the Forillon along the south ridge.

The behavior described above could be ascribed wholly to the strength of attraction by sunny areas as sign stimuli, or partly to a weakening of these warblers' internal motivation (N. Tinbergen, 1948) to move southeastward, due to the height of the saddle toward which they had been ascending along the brook.

Migration of Crows and Jays

At the end of the breeding season a flock of a hundred or more crows, probably residents of eastern Gaspé, assembles to feed on fish offal spread as fertilizer on the fields of the Forillon, and to compete with the gulls for scraps at the cod-dressing stands on the little beaches. The birds range freely up and down the length of the little peninsula. True to their roving nature they visit all parts of it, even searching the rocky footings of the northern cliffs, regular hunting grounds of their larger relatives, the ravens. The shift from place to place may take place very rapidly. A group may be feeding beside the wharf at Grande Grève; suddenly they rise and mount into the western highlands, or again disappear over Bon Ami Heights behind Indian Cove, as if the highest points were the most inviting to such energetic birds. At other times all fly northwestward along the shore toward Little Gaspé, and may be encountered far up the bay.

The number of crows increases annually about September 1. Observations along the St. Lawrence shore indicate an eastward drift. Flocks of more than 200 may then reach the Forillon. Since none ever seem to cross the bay, but they are often seen in flocks about its western end as well as along the south shore, one may assume that, like other species, they pass around Gaspé Bay in migration. At Point St. Peter flights have been traced to the shore of Malbay in late September.

No evidence that crows migrate overland across the Gaspé Peninsula has been obtained. Even during the nesting season they are chiefly restricted to the coastal belt. In migration time they penetrate the river valleys little farther than the heads of estuaries, or the inner margins of cleared lands.

Jays, on the contrary, have seldom been encountered near the coast during the breeding season or for some time after it. Canada jays (*Perisoreus canadensis*) prefer the inland forests. The nearest suspected nesting locality noted in the region about Gaspé Bay is in a secluded tamarack swamp 8 miles inland on the divide between the York and St. John rivers. After the young are on the wing this species descends to the forest margin. Only once have they been seen on the Forillon—2 in dense spruce in the coulée north of St. George's Cove on August 29, 1939. South of the bay a few spent September behind the farms at Sandy Beach and Haldimand in 1948.

Blue jays (*Cyanocitta cristata bromia*) have yet to be recorded nesting on the Gaspé Peninsula. I have never seen or heard this species earlier than August 14. Each year from 1 to 6 visit the Forillon, but none have been observed near Cape Gaspé. South of the bay a few have been seen at Sandy Beach, Haldimand, and L'Anse à Brillant, and one at Ste. Anne des Monts September 23, 1948.

The only blue jay reported inland is one found by Anderson at Lake Ste. Anne, recorded by Demille. Although, according to Macoun (1909), this species is an abundant resident in New Brunswick, common even along the Restigouche, it is rare in northern and eastern Gaspé. Observations are needed in the southern and southwestern parts of the peninsula. I have never seen it while passing through the coastal parts and the Matapedia Valley. Macoun reports blue jays uncommon in Newfoundland. Braund and McCullagh (1940) saw none on Anticosti but refer to Schmitt (1904) as having found them even common there at times. Macoun says that a few breed along the St. Lawrence, far up the river, southwest of Gaspé. It seems unlikely that the few migrants seen in northeastern Gaspé originated as far away as Leeds and Renfrew counties, but from some eastern locality, possibly Anticosti Island, or New Brunswick, or more likely from western Gaspé itself. One may also expect to find a few jays among the birds that migrate eastward along the northern coast of Gaspé.

Migration of Blackbirds and Starlings

Rusty blackbirds nest about the inland lakes, and a few red-wings (*Agelaius phoeniceus*) in the cultivated coastal belt. In August these appear in mixed flocks, up to 500 in number, about the head of Gaspé Bay. There they are joined by some 50 starlings (*Sturnus vulgaris*) that breed in the region, and disappear by a route as yet unknown. Probably it is coastwise, via Percé, to the southeast.

Bronzed grackles (*Quiscalus versicolor*) also breed near the coast, but depart earlier than the others. Mr. Frederick Richmond, an observer of birds in Gaspé for over 60 years, had long been especially interested in grackles. He told me that they gather in flocks during the middle of July and depart for the south from his residence in Gaspé village about the 20th, "straight for the Forks of the St. John." This juncture of the two upper branches of the river lies some 40 miles southwest of Gaspé, well back in the forest. It is doubtful whether these birds really proceeded westward farther than the head of the York estuary, possibly crossing the divide into the lower St. John Valley, and thence southeast around the end of the Gaspé Peninsula.

At Grande Grève flocks of grackles have gathered as early as July 16 and departed to the head of the bay on the 19th (1941). At Sandy Beach on the south shore in 1946 they were on the move toward the southeast on July 27 and 28—16 and 82 birds respectively.

In autumn grackles again appear. On October 13, 1941, a flock of about 100 fed in a dooryard near the north shore of the St. John estuary. Demille saw a flock of 50 near Mont Louis, October 16, 1923. These autumn migrants may come down the St. Lawrence from the southwest; they breed commonly in the vicinity of Quebec and Montreal. They also inhabit Anticosti in sufficient numbers to produce flocks of this size.

MIGRATION OF PASSERINES WEST OF THE FORILLON

Thus far, migrating passerines have been considered from the point of view of the Forillon. We have now to review the evidence from farther west. Birds leaving Grande Grève reappear beyond Little Gaspé in several places suitably located for easy observation. One of these is along the high road which skirts the shore. Through the first 4 miles much of the route is still forested. Here the edges of the road are followed by many migrants. From a point one-quarter mile east of Rancelle Hill, where Route 6A turns up over the mountain toward Cap des Rosiers, the forest has been cut back, leaving a margin that passes obliquely northwestward to the top of the lower southern ridge. Many warblers follow this line. Others follow the top of this ridge through the forest, to appear at the road crossing (X on Fig. 10).

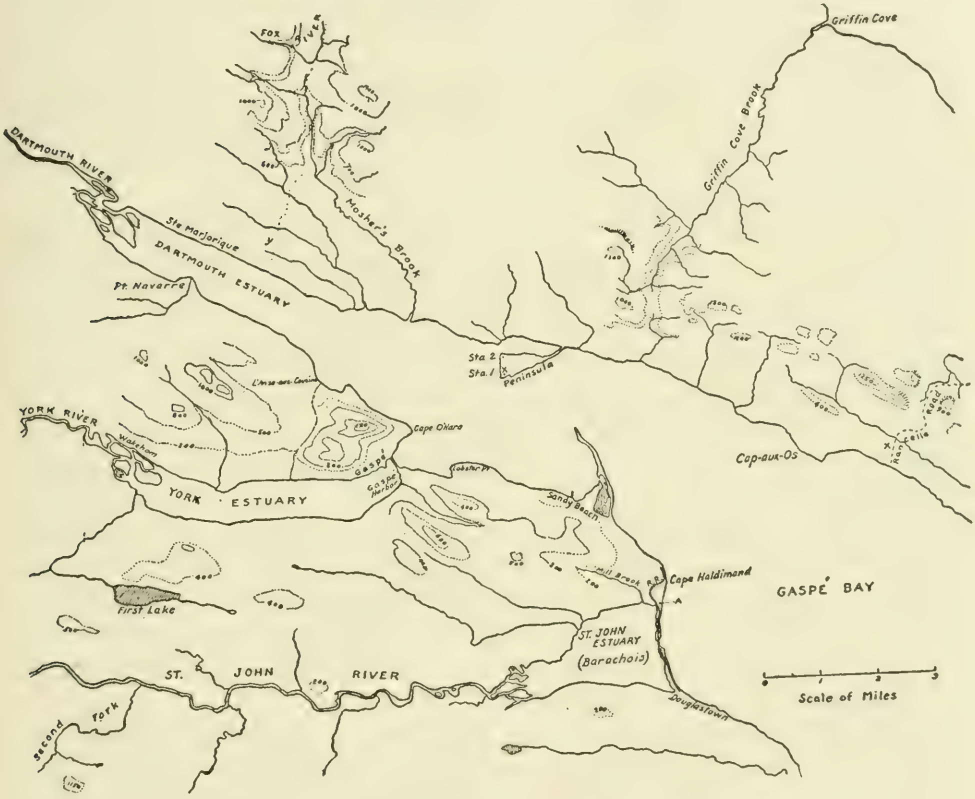

Griffin Cove
Fox River
Griffin Cove Brook
Dartmouth River
Mosher's Brook
Ste Marjorique
y
Dartmouth Estuary
Pt. Navarre
Sta 2
Sta. 1
Peninsula
L'Anse-aux-Cousins
York River
Cape O'Hara
Wakeham
Gaspé
Gaspé Harbor
Lobster Pt
York · Estuary
Sandy Beach
Cap-aux-Os
Road
Rancelle
Mill Brook
Cape Haldimand
Gaspé Bay
First Lake
St. John Estuary
(Barachois)
St. John River
Second Fork
Douglastown
0 1 2 3
Scale of Miles

Figure 10. Map of the Gaspé Bay region.

Two miles farther up the bay the tree line again descends to the shore and is followed by many birds. The same configurations appear intermittently to the westward, except that beyond "Peninsula" a more or less continuous row of trees fringes the low cliffs and banks along the bay. These are frequently used by migrants.

Peninsula itself is a low triangular piece of land projecting obliquely southwest into the bay for 1¼ miles (Fig. 10). West of its narrow connection with the north shore is a lagoon. Much of this peninsula is forested. During migration many warblers are attracted to it. In 1941 I devoted several mornings to a study of their behavior. Most of them followed the shore line to the outermost southerly limit of the forest. A few, as though trying to get as far south as possible, flew to isolated spruces beyond the uncut timber. They all returned to the forest and worked westward till they again met the shore. This turned them back toward the main north shore, to which they finally flew across the narrow mouth of the lagoon to Ascah's Point, some 500 feet away.

With one exception, after reaching the outer end of the peninsula none tried to cross the bay. The exception was provided by 2 myrtle warblers that had reached the shore trees at X (Fig. 10). After a short period of feeding they set out over the water toward Gaspé Harbor, about 2 miles away. But like those at Shiphead reported above, they traveled only a few hundred feet over the water before turning toward the north shore. Through binoculars I saw them land in the trees west of Ascah's Point. There they undoubtedly joined the flight of warblers, westward along the cliff margin.

So loath are most of these migrating passerines to fly over water that, rather than cross the mouth of Mosher's Brook, a little estuary 200 feet wide, the majority of them work upstream through the bordering trees until the gap has narrowed to about 50 feet. Some pass even farther upstream before crossing. This illustrates the "ecologic compulsion" toward food proposed by Schüz (1950).

Higher on the south ridge overlooking the bay three roads cross toward the St. Lawrence shore. Route 6A over Rancelle Hill has been mentioned. Not only at the top of the lower ridge, but in the higher crossing of the Appalachian backbone, migrants often have been observed in westward passage; comparatively few passed eastward. Five miles farther west the Griffin Cove portage affords another favorable line for observation. Seven miles still farther up the bay, the Fox River portage carries Route 6 over the mountains. At various lookouts along these two roads the results have been as at Rancelle—the great majority of migrants along the southern ridge were passing west. Late in the season robins and thrushes were added to the last of the warblers. Being larger and noisier they proved easier to follow. To the observer at Y (Fig. 10) they seemed bound up the Dartmouth Valley whose wide mouth yawned 3 miles ahead.

SOUTHWARD CROSSING OF THE DARTMOUTH RIVER

The Dartmouth estuary, like those of the York and St. John rivers, has extensive treeless, grassy marshes at its upper end. Rather suddenly these give way to forest that borders the river for some hundreds of yards, forming for the birds, as it were, a broad bridge of trees succeeded by more open land farther upstream (Fig. 10).

Observations reveal that hundreds of warblers, vireos, robins, and thrushes cross the Dartmouth in this belt of woods. The river here is some 200 feet in width. Most of the fringillids that prefer brushland appear to attain the western margin of the forested belt before crossing the river. Here also cross many of the warblers, robins, and thrushes that come down the Dartmouth's north shore from the opposite direction. It is probable that many of those mentioned above as passing westward over Route 6 find their way down from the top of the ridge along the forest margin and cross the river here. None has been seen to cross the marshes below, or the bay. The nocturnal migration of thrushes is reserved for special treatment beyond.

It appears, therefore, that the passerine migrants which originate in, or reach that part of the Gaspé Peninsula lying north of the bay pass around rather than across it. Certainly diurnal migrants are abundant along the south shore, and the slopes behind it, as far east as Gaspé basin.

MIGRATION SOUTH OF GASPÉ BAY

Migration south of Gaspé village presents confusing problems to the birds as well as to the observer. At Cape O'Hara the shore line bends to the right at an acute angle and continues inland for 7 miles as the north bank of the York estuary, or "southwest arm" of the bay. This quiet body of water is about a mile wide through most of its length, but narrows to a quarter-mile at its mouth where Route 6 crosses the drawbridge in the village.

After working their way southeastward along the southern shore of the Dartmouth estuary, diurnal migrants turn sharply westward among the trees over Point O'Hara and continue through scattered dooryard trees in the village. Most of them keep to the trees and shrubs on the steep slope along shore until they reach the bridge abutment of Route 6. Here stands the last spruce tree on the river bank. It is a striking experience to see a group of myrtle, yellow, and magnolia warblers accumulate in this tree, and then set out over the main traffic intersection, a busy repair garage, and several other buildings, toward trees standing higher on the slope in the dooryards of residences behind the business district. These birds eventually work back down the slope beyond the village and continue westward along the estuary shore. This performance is repeated almost daily through the migration season.

At the bridge one occasionally sees evidence that a bird senses the shore at the other side of the harbor. Now and then a myrtle warbler nervously ascends from branch to branch on that last spruce tree. It runs out to the ends overhanging the water, looks toward the opposite bank, crouches as though to spring into flight, but hesitates and rises to another branch. This performance is repeated until the topmost twig is reached. There the bird turns this way and that, but faces chiefly toward the water. One feels certain that the bird is about to cross it. But the attraction of the land is too great in most such instances; the warbler finally flies across the street in the path followed without hesitation by the great majority of migrants.

A single myrtle warbler actually flew out over the water, but it soon swerved down to the metal framework of the bridge and thence back over the village.

At the head of the York estuary migrants that have followed its north shore repeat the behavior described on the Dartmouth. The relation of marsh and forest is similar, while the river is somewhat narrower. Warblers here cross to the south bank and work back to the east. Throughout the 6½ miles, group after group filters along through the birches, firs, and spruces that border the shore. Robins likewise follow this path. This species shows a tendency to diverge into the pastures and fields on the slope above to feed.

Near the southern end of the drawbridge, birds that have returned along the south shore of the York estuary turn upward over the shoulder of a hill, clinging to the forest margin. This directs some of them through scattered trees to a narrow fringe bordering the southern shore of Gaspé Bay. The majority, however, work eastward for 3 miles at the upper (southern) edge of the cleared land behind the farms.

About a mile west of the St. John estuary the forest margin descends obliquely to the shore at the base of Sandy Beach Peninsula. Here the two streams of migrants reunite and continue southeastward. Some follow the shore. Others are attracted by a railway cut through half a mile of dense forest. Upon reaching the cleared lands of Haldimand these birds turn to the right with the forest margin and trace it westward. Crossing Route 6 again just above its own turn to the west they skirt the base of a spur from the hills and continue along the tree-line. This brings them to the inland border of the farms occupying the broad flat lands that front on the north shore of the St. John estuary.

Some groups continue 3 miles westward along the woods' margin at the base of the slope until it approaches the river beyond the settlements. Here the St. John passes through forest only partially cleared along the highway. The latter crosses the river in this area and turns back along the south shore of the estuary toward Douglastown.

Before pursuing farther the birds just considered, it will prove illuminating to trace the other groups that follow the shore from the base of Sandy Beach Peninsula. These continue among the trees at the top of the shore cliff as it sweeps southwestward in a long curve toward the mouth of the St. John estuary.

An unusual configuration of land and water obtains here (Fig. 10). Unlike the Dartmouth and York, the St. John is closed by a bar through which the river passes at the "tickle." This narrow channel is only 100 feet wide where it is spanned by the bridge of the railway built along the bar. A filled embankment some 20 feet high supports the single track for a distance of about 2 miles between Haldimand and Douglastown. Behind the bar the broad estuary, or "barachois," extends 2½ miles west, and terminates in a wooded swamp bordered by grass-covered marsh.

The bar lacks trees, except three little groups of spruces at the north end where the Haldimand shore-forest tapers off. From the western edge of these conifers a treeless belt 400 feet wide intervenes for the passage of the railroad upon the bar. At the foot of the embankment west of the track stands a 40-foot spruce whose top is visible to birds reaching the trees on the east side of the track. To the west beyond it, the north shore of the estuary is fringed by an almost unbroken line of trees.

Passerine migrants might well be expected to follow the bar from north to south. Actually few of them show any inclination to do so. The great majority of those that come down the bay become concentrated in the three acres of uncut woods at Haldimand Beach. An observer stationed at A, Figure 10, sees small groups frequently crossing the railroad to the tree above mentioned. Now and then a bird or two, as though more stimulated by the southward urge, flies out to the isolated stunted spruces in the open. Most such birds either return to the woods or fly west across the railroad. Before doing so they show more or less confusion or indecision. For example, on September 13, 1946, between 6:48 and 7:08 A.M., three groups of 4, 2, and 5 myrtle warblers thus visited the last of these trees. When they again took flight each little flock struck out along the sand dunes, turned, circled, and doubled back, finally crossing the railroad like all their companions. During several weeks of daily observation distributed over seven years, I have seen but 3 warblers fly farther out over the beach grass. None of these proceeded as far as the bridge; each suddenly veered down to one of the few 2-foot shrubs that had sprung up at the top of the railway embankment. Thence the bird made its way back to the shore fringe of trees.

For the next 2½ miles, as on the York, the migrants passed westward to the head of the estuary, to cross through the first available trees growing in the swamp. At the southern border of this woods, near Route 6 in Douglastown, stands a fine spruce 20 feet higher than those in the swamp below. To this tree, after crossing the St. John, many warblers and robins ascend. From it they can easily be seen passing up to the forest margin on the southern slope of the estuary.

From here many birds work eastward to the bay shore. There they turn southeastward again. On any good migration morning, between Douglastown and Point St. Peter, this movement can be followed. The railway, winding through the forest along the slope, furnishes many good observation points. For example, at L'Anse à Brillant, many robins annually pass eastward, feeding here and there on blueberries beside the tracks.

Still farther back from the shore, beyond gentle slopes, rise the mountains that swing southeast above the St. John River bridge already mentioned, and terminate between Malbay and Barachois. Judging from observations made one morning on a tributary of Malbay River, a considerable number of migrants pass southeastward along this slope. Further study is needed in order to determine whether some birds from the St. John watershed use this route instead of the above outlined path along the bay.

Diurnal migration south of Gaspé Bay, as thus far delineated, appears rather simple, a sort of grand right and left, in and out, of the estuaries and along shore.

I have now to report some movements in the opposite direction. Beginning at Seal Cove, east of Douglastown, small numbers of migrants have been noted working northwestward among the trees at the top of the shore bluff. Others pass westward along the south shore of the St. John estuary. On several occasions, at the highway bridge farther west, birds have passed upstream. The same westward flight occurs every year past a favorably situated clearing on the north bank a mile above the bridge. Whether these birds have ascended the south or the north border of the barachois is unknown, for these lines merge in the woods below the bridge. Thus far brief studies along the upper waters of the St. John have shown several diurnal movements of warblers and sparrows to the west—upstream—as on the York. Less evidence of eastward progress has been observed.

At Haldimand each fall hundreds of warblers, chickadees, and kinglets descend the river along the north shore of the estuary. At the mouth of Mill Brook, 300 yards above the bar, a deep angle in the low cliff affords an excellent location from which to check migrants. Many have been followed to the railroad and across it to the spruce woods at Haldimand Beach. Some of them then work inland along their western margin; others skirt the beach and shore cliffs, passing on northwestward through scattered young evergreens and alders that border them, until they reach the woodland near the base of Sandy Beach Peninsula. From here their paths are the reverse of those described above between the mouth of the York estuary and this point.

A significant added circumstance is that before 1941 a number of warblers used to follow the fringe of trees around Lobster Point and Lobster Cove (Fig. 10), and turned upward over the bluff at the south end of the highway bridge at Gaspé Harbor. This movement was heavy on September 21, 1941. Thence they worked westward along the southern shore of the York estuary. During the war a large area was cleared for a naval base on the eastern side of Lobster Point. Since this interruption of the shore tree-line, migrant warblers are shunted inland east of the base and follow a broken line of scattered trees and groves to join the flight-line along the woods margin higher up the slope. This furnishes another example of the attraction of diurnally migrating warblers to trees.

Robins, which obtain much of their food from the ground, still drop down to the fields on Lobster Point. Moreover, on at least three occasions their behavior at Gaspé Harbor differed remarkably from that of myrtle warblers. Shortly after dawn, October 3, 1941, both species were abundant. From the bay slope the warblers were coming westward up the south shore of the estuary. One flock of 16 chickadees accompanied them. The robins also presumably approached Gaspé Harbor by the same route. At any rate from my observation point below the hill (O in Fig. 11), I could see them coming from the east into scattered trees at its top. By 5:50 A.M. about 20 birds had gathered there. At 6:00 A.M., 11 robins without hesitation flew high and directly across the harbor, alighting far beyond the

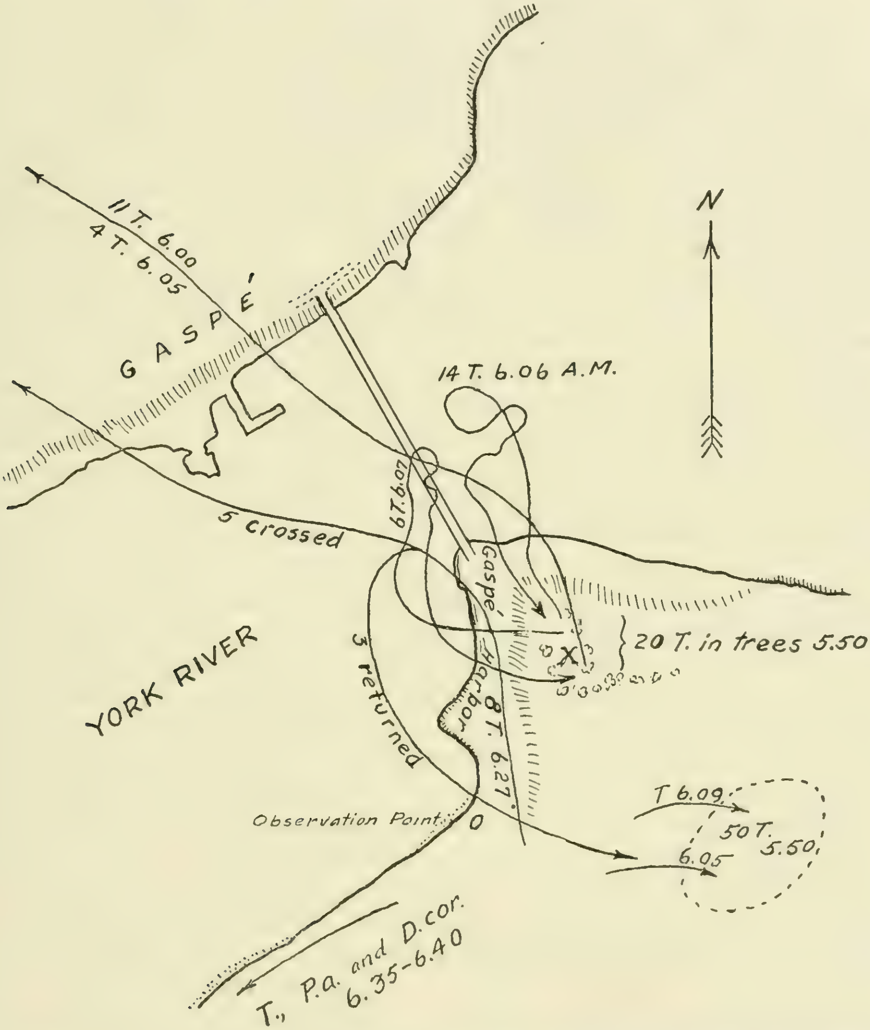

11 T. 6.00
4 T. 6.05
GASPÉ
14 T. 6.06 A.M.
N
6 T. 6.07
5 crossed
Gaspé Harbor
X
20 T. in trees 5.50
YORK RIVER
3 returned
8 T. 6.27
Observation Point
O
T 6.09
50 T.
5.50
6.05
T., P.a. and D. cor.
6.35-6.40

Figure 11. Northward crossing of York estuary at Gaspé village by robins.

village on the sunlit northern slope. Four others took very nearly the same path at 6:05 A.M. One minute later 14 robins struck out for Cape O'Hara, almost due north, but soon veered back to make another attempt along the path of their predecessors, finally returning to the trees on top of the hill. Thirty seconds later 6 of these same birds again flew out high above the bridge, towered steeply and circled back when halfway across, to a grove 100 yards west of their starting point.

For a time these robins worked westward some 300 yards as though to pass on up the river. It was therefore the more striking to see 8 of them at 6:27 A.M. suddenly fly swiftly back eastward along the shore toward the bridge, above which all rose to a height of 300 feet and headed directly across the narrows for the sunlit slope. When one-third of the channel had been spanned 3 birds swung back to the forest margin high on the slope southwest of the trees they had left.

Incidentally, at 5:50 A.M. about 50 robins had worked along this forest margin into a valley that leads southward behind Sandy Beach to the headwaters of Mill Brook and eventually to the St. John estuary. A few others followed them at 6:05 and 6:09 A.M. This proves to be an avenue used by a considerable number of migrant robins and thrushes, confirmed by daily observations behind Sandy Beach.

As an interesting corollary of the abortive attempt of 6 robins to cross the mouth of the estuary at 6:07 A.M., 2 myrtle warblers at that moment were passing northeastward along shore toward the bridge. Seeing the robins, they rose as though to accompany them. Outdistanced, the warblers nevertheless continued and alighted in trees above the main street of Gaspé, while the robins doubled back. It was to be six years later before another warbler was seen making this south to north crossing; on October 25, 1947, a pair of myrtles again worked down the south shore, and instead of following the forest margin eastward as usual, found their way into a small group of trees at the south end of the bridge. After feeding there a few minutes they set out for the opposite shore, hesitated and gyrated rapidly for a moment as they found themselves above the water, then continued beside the bridge to spruces on the farther bank.

On October 4, 1941, robins at Gaspé Harbor performed much as on the 3d. At 6:25 A.M. about 50 had gathered in trees on the slope (X, Fig. 11). Within the next few minutes they were joined by others coming down the river. At 6:32 A.M. the entire flock rose noisily and flew out over the water, but the majority of them turned back at the halfway mark. A few had nearly reached the north bank when they, too, returned. Half an hour later 16 others set out; 13 soon curved back, but 3 kept straight on across the mouth of the estuary. A moment afterward 2 starlings crossed, and a robin accompanied them one-third of the distance before returning.

One other northward crossing here by robins occurred on October 14, 1941. The 7-inch snowfall of the 11th still covered the ground and had increased the attractiveness of mountain ash berries to robins. More than 80 were seen about large dooryard trees that day. At 6:15 A.M. several were feeding near the same observation post occupied on the 3d, as described above. Ten minutes later 8 others left the trees on top of the hill and flew high across the channel above the bridge. These, too, continued over the village to the hillside above. On this clear, cold day the snow increased the brilliance of this slope, and doubtless thereby its attractiveness to these birds.

Returning to the earlier date of October 3, 1941, when robins crossed the harbor, it is interesting to note that robins, myrtle warblers, and chickadees (*Parus atricapillus*) were flying westward (inland) along the south shore of this estuary. The robins increased in numbers toward its head. At 7:00 A.M. four groups were progressing by flights of 100 to 300 yards directly parallel with the shore.

A mile farther upstream at 7:40 A.M., a large concentration was discovered on the slope above the shore flats. Some were feeding on blueberries. Others showed mild excitement by short flights to and fro, accompanied by much piping. Between 7:43 and 8:10 A.M. four groups of 12, 32, 28, and 6 flew toward the partially cleared crest of the hill; the largest of these disappeared over the crest as though to enter the St. John Valley. At 7:52 and 7:57 A.M. two other groups descended in the opposite direction to the bank of the river and turned westward up the York. Another small flock took a parallel course along the slope.

On the following morning robins were again conspicuous in this vicinity. Between 9:00 and 9:10 A.M. more than 70 were seen flying back and forth, up and down the slope, but advancing definitely westward.

To summarize, on this morning robins in the vicinity of the York estuary were seen flying in all directions except across Gaspé Bay. It is suspected that, meanwhile, there was sustained flight southeast along the bay shore into the St. John Valley, also contributory flights to the latter across the low divide from the head of the York estuary. For future reference it may be noted that these robins leave the York at a point opposite a locality on the St. John where this species passes westward upstream every autumn (cf. p. 45). And we have just seen that at least two large groups ascended the York on October 3, 1941.

Thus far, though carefully sought, no evidence of westward migration along the south shore of the northwest (Dartmouth) arm of the bay beyond Battery Park has been recorded. Furthermore, but few diurnal migrants seem to pass eastward along the north shore of the York estuary. This is in distinct contrast with their behavior on the St. John, where, for example, at the mouth of Mill Brook (Fig. 10) warblers were often seen passing each other in mid-air, some east and others west.

WESTWARD MIGRATION ALONG THE RIVERS

Of the 80 robins that concentrated in the village of Gaspé after the October 11th storm in 1941, several groups departed westward along the slope above the estuary. Inquiry among farmers farther west provided evidence that some of these birds continued for several miles. On the 14th I saw a group of 8 flying definitely westward in Wakeham on the north shore, near the head of the estuary. At what may be called the mouth of the river proper a general drift of robins upstream along the south bank occurred on the morning of September 28, 1941.

Farther upstream numerous instances of diurnal westward passage can be cited. On October 15, 1941, about 20 robins were seen flying west beside the road through heavy forest 9 miles above the mouth of the river, and other groups in the 1921 "burn" beyond, all trending westward. At "No. 17," 12 miles up the river, on October 10, 1941, several robins worked slowly westward just after dawn. Three miles beyond, from the two notches in the divide between Dartmouth Lake, headwaters of that river, and the York Valley, more than 300 robins poured southward along Mississippi Brook (Pl. 1, *C*). One group of 75 after reaching the valley floor continued beside the brook toward its juncture with the York. The others spread out to feed upon blueberries; in general they trended westward, and 3 miles above, a flock of 50 were definitely headed upstream.

Three mornings previously an even greater number of robins had thus come down from the northern hills. These also trended westward. On another occasion, September 24, 1941, 11 miles farther upriver where the stream flows southward many robins fed slowly westward until they reached the river bank. One large flock then rose, crossed the York and ascended an extremely steep, spruce-covered slope, alighting in trees some 300 feet above the river. If they continued along this course they probably entered Tom's Brook pass (Fig. 2) through which later a "short-cut" logging road was opened to reach a southward bow in the river several miles beyond. This valley would thus have led them once more to the York, and at the most southerly point in its course. Here from the south enters Caribou Brook, an important tributary later to be considered.

Toward this same point, on September 24, 1941, myrtle warblers were making their way southwest across the road at Whitehouse Camps, north of the next eastward major bend in the river. These birds may have flown south from the Madeleine Valley. No progress farther westward has been observed. As a matter of fact this southern bend in the river lies within 7 miles of its source. Studies in 1949 and 1950 showed that thrushes, via Caribou Brook, cross the divide toward the headwaters of the St. John and the Bonaventure. Hunters have reported robins in the blueberry "burns" there in autumn.

York Lake, the source of the main stream, is about 2 miles long and its main axis is north and south. As stated in the introduction, only a low divide separates its upper end from the valley of the Madeleine on the north. Surprisingly enough, however, more birds have been seen working northward along its shore, and along the river below, than in the opposite direction. For example, on September 13, 1948, between noon and 3:00 P.M., 35 myrtle warblers ascended the river and passed northward along the east shore of the lake. In other years a few red-breasted nuthatches have been recorded following the same route. Actually the only southward migrants seen during many visits at the lake were 2 pigeon hawks that coursed down the west shore, stopping now and then to capture dragonflies over the water.

An eastward diurnal movement along the York was noted near Fall Brook on October 10, 1941: a flock of about 30 tree sparrows (*Spizella arborea*) when disturbed beside the road rose and flew downstream above the forest. Juncos and myrtle warblers have repeatedly been observed working eastward near Beaver-dam.

On the Dartmouth and St. John rivers, migration studies have thus far been confined chiefly to the lower parts. None have been conducted along the former beyond the last settlements, 3 miles above the head of the estuary. Except for some 20 olive-backs that flew upstream along the north bank as others crossed the river, all diurnal and nocturnal migration observed there has been eastward (downstream).

A better picture has been obtained of fall flights along the lower 5 miles of the St. John. At the highway bridge beyond the estuary on numerous occasions warblers were seen passing westward. Except for a few small clearings made by lumbermen, no open land exists above the bridge on the north side of the river, or for more than a mile on the south side. Wood roads, however, provide access to these bottom lands.

Morning trips for 3 miles along the southern bank have shown that warblers ascend the river, at least in small numbers. In contrary movement were a few thrushes and robins, the latter along the edge of the most remote cleared land. This stands on a bench 50 feet above the wooded river flats.

On the north bank a nearer approach to the river can easily be made in several places. Along this bank many warblers have been observed working westward among the mixed conifers and birches. From the clearings higher on the slope each fall hundreds of robins have been recorded in westward flight. Many of them pass down the slope from the northeast to a clearing of some 3 acres. It was on the York (north) slope of the ridge nearly opposite this clearing that, as previously stated, on October 3, 1941, a large flock of robins ascended and disappeared toward the St. John. Two myrtle warblers had done likewise on September 17. Perhaps this low part of the divide, studded with blueberry clearings, is regularly used by this species in proceeding southwest.

However, it is believed that most robins which ascend the St. John follow the forest margin all the way from the vicinity of Mill Brook and Haldimand railroad siding. It is here that the highway from the bay shore cuts through the forest and turns westward up the estuary. Just above this sharp curve in the road hundreds of robins each fall can be seen swinging westward from their course down the shore of the bay. They are joined by others that have flown a parallel course down the valley from Gaspé Harbor behind Sandy Beach to the point where Mill Brook emerges from the forest. Thence they have been followed for 3 miles along the edge of the forest and among the fields to the St. John bridge. Here stands the last small farm. Only cart roads and occasional wood lots break the forest beyond. Through this region pass most of the robins seen farther upstream. As yet these have not been traced more than 5 miles. Some of them may ascend for many miles as on the York. Others may cross the river where the valley narrows and turn eastward along the northern flank of the mountains that end at Malbay.

It has already been stated that warblers cross the St. John southward through the trees at the head of the estuary. Small numbers of robins also follow this path, some having come west in the trees along shore, others having left the main line of flight at the base of the north slope to follow a strip of uncut spruces across the fields to the bank of the estuary just below its head. Even to robins, a species less restricted to trees than are warblers, broad estuary and open marsh apparently constitute a barrier to diurnal progress southward; the few that cross the St. John below the highway bridge pass through, and over, the wooded swamp along with the warblers.

CROSSING OF ESTUARIES

Besides ducks, herons, and shore birds only three species of passerines freely cross the estuaries. One is the crow; in its wanderings up and down the south shore of Gaspé Bay it frequently, without hesitation, crosses the wide mouths of the York and St. John. At sunset one evening more than 70 flew in a straggling group from Douglastown to Haldimand along the bar at the mouth of the St. John. They were on their way to a roost in the dense spruces near Mill Brook. Others at any time of day readily cross the open water of the barachois above.

Another species is the horned lark (*Eremophila alpestris alpestris*). After their appearance near the coast in October, flocks up to 50 in number of individuals frequent the shores of the estuaries and the fields above them. When disturbed on the beach they are quite apt to fly across to the other shore. On one occasion a large flock descended from the north slope behind Gaspé basin, crossed the village and continued over the water toward extensive fields far up the opposite shore.

The third species is the pipit (*Anthus spinoletta rubescens*). Like the horned larks these birds in autumn gather in the fields, less often along the shore, about Gaspé Bay. They, too, freely cross the estuaries.

Neither crows, pipits, nor larks have been seen crossing the bay itself; not even the tip of the low, narrow Sandy Beach Peninsula that stretches out 1½ miles into the bay seems to direct them toward the north shore; only 1½ miles of water intervenes. Many a group has been seen to approach the tip from the base on the south shore, but all have turned back at the end, some in flight, others on foot as they searched the beach for food. This example is not necessarily shorn of its impressiveness by the identical behavior of sandpipers and sanderlings. Although there is some evidence that these shore birds at times cross the upper part of the bay diurnally, it will nevertheless be surprising to find horned larks doing so.

As previously cited, on a single occasion a small group of thrushes crossed the Dartmouth estuary from north to south.

MIGRATION OF THRUSHES

In describing the behavior of migrants through the Forillon, thrushes have been cited as the only passerines that could be so easily heard at night as to enable the listener to determine their lines of flight at Grande Grève. Nocturnal migrants are generally believed to make more sustained flights than do such species as robins and sparrows which, during the day, proceed by short flights, stopping here and there to feed. It is well known that warblers thus advance in daylight, but they also are believed to make long journeys at night. However, their calls are weaker and much more difficult to follow than those of thrushes. Indeed, very few nocturnal flight notes that could be attributed to warblers have been heard in Gaspé.

Since the nocturnally migrating thrushes can be traced for distances of at least a quarter of a mile by their frequent call notes, special attention has been given them. The assumption may perhaps be warranted that, unheard, other passerines here follow the same general flight pattern at night.

RANGE OF THRUSHES

In the northern parts of its range the eastern hermit (*Hylocichla guttata faxoni*) breeds throughout the Maritime Provinces, Anticosti, Newfoundland, and from southern Labrador through southern and central Quebec south of tree limits to the Yukon. Austin (1932) records it as rare in southern Newfoundland Labrador.

The range of the olive-back (*H. ustulata swainsoni*) is similar, extending somewhat farther north in Newfoundland Labrador than the hermit's. Both hermits and olive-backs are common residents about Lake Mistassini in north-central Quebec (Godfrey, 1949).

The eastern range of the gray-cheeked thrush (*H. minima minima*) lies wholly north of the St. Lawrence River, except that it includes Newfoundland. In Labrador this thrush has been recorded far north at Nain and Chimo. In the west it is found south of tree-line through northern Manitoba and Mackenzie to northern Alaska, and even in northeastern Siberia. Bicknell's thrush (*H. minima bicknelli*), a small race of the gray-cheek, curiously enough replaces the large race along the southern Labrador coast east of Natashquan. In Gaspé Wynne-Edwards (in litt.) found it not uncommon above 3000 feet in the Shickshock Mountains, and in 1951 I heard them a few miles southwest of Tabletop, leaving the Mt. Sterling area that lies above 2500 feet.

A few Bicknell's thrushes nest in the highlands about Mt. Alban just west of the Forillon. Wynne-Edwards (in litt.) found them in the higher Shickshocks. Taverner took a few specimens of this race on the mountains back of Percé, and Townsend (1920) saw and heard others. Gillette (1935) studied their songs there. It will not be surprising to discover this thrush on the high forested hills that border the St. Lawrence River between Fame Point (east of Grand Étang) and Ste. Anne des Monts. Thus far none has been recorded in the interior of eastern Gaspé. From the region between northeastern Gaspé and the mountains of northern New England this subspecies is still unknown as a breeding bird (Wallace, 1939). The only gray-cheeked thrush seen was on June 2, 1936, probably a late migrant (Ball, 1938). It does not normally nest south of the St. Lawrence. One must interpret, as being applicable only to *H. minima bicknelli*, Bond's statement (1926) that the gray-cheeked thrush (*Hylocichla a. aliciae*) is "not uncommon in northern Gaspé."

The common nesting thrushes of Gaspé are the olive-backed thrush (one brood) and the hermit thrush (two broods, usually). Throughout the forested regions the former is more abundant, while the latter predominates in the marginal districts. On the Forillon the olive-back breeds commonly, but hermits are seen only during the migration season.

After the second brood emerges the adults become very quiet. During this period of molt one sees them only occasionally in dense forest or shrubs.

IDENTIFICATION OF MIGRANT THRUSHES

While auditory identification of migrant thrushes as a genus is easy, considerable acquaintance with their calls is necessary in order to distinguish the various species. Their songs and notes are of lower pitch than the highest warbler songs. For example, Mathews (1921) places the highest notes of the olive-backed thrush nearly two octaves below the black-poll warbler's song. To my ear the average pitch of thrush flight notes is somewhat less than an octave above the white-throated sparrow's song. The range in pitch of hermit and olive-back calls is about three notes on the scale.

The distance range of audibility, both horizontally and vertically, is, of course, very important. The former, under optimum conditions, was established for the loudest notes at about 2000 feet. This was done by measuring the distance to positions where olive-backed thrushes continued uttering flight calls after descending to the ground at dawn. Only cases in which no shrubs or trees intervened to deflect sound waves were used in these determinations.

According to physicists these calls should be heard as far vertically as horizontally. But certain modifying factors, considered in the Appendix (p. 197), suggest a maximum vertical limit of 1500 feet. Possibly, space above the trees being free of all obstructions, this should be increased.

Under exceptionally favorable circumstances one learns the flight call of a bird by first hearing it in the air, and again immediately after the bird's descent to the ground or vegetation at dawn. The bird may then be either collected, or watched until identification is certain. When two species are migrating together great care must be used to avoid confusion.

Easier to record is the transition from flight calls to diagnostic ground notes at dawn, or vice versa in the evening. Very satisfying is the "*chuck*" of the hermit close at hand in the brush, after the listener has been recording the whistled pipes of migrants passing overhead in the dawn twilight. Usually a hermit, upon descending to the ground, immediately terminates its flight notes; it normally utters the ground call promptly, as if expressing enthusiasm at the prospect of finding food. Occasionally a bird may be dimly seen descending into the brush, or it barely misses striking the observer as it flits past him. He senses the thrush still close at hand, but may have to wait several minutes to hear the anticipated call.

Occasionally a bird continues its flight note after alighting, or resumes it after disclosing its identity through ground calls—an interval sometimes as long as 10 minutes. Such belated calls may truly be surprising, as well as very helpful in identifying the migrants concerned.

Identical ground notes from various points indicate that the recent flight was purely of hermits. One should be prepared to detect a soft *chu.* This may prove to be an olive-back; if there follows a short *puk* of higher pitch, or a *puk-kée* in which the second note is emphatically higher still, the identification is confirmed.

Another species that should be kept in mind when the *chuck* is heard is the gray-cheek, said by Bent (1949, U.S.N.M. Bull., 196, p. 195) to use this note. Possibly for this race the ground call has more of Bicknell's *chook* sound noted by Wallace (1939). This last quality has not been detected in Gaspé. *Chuck* calls, even during mid- and late September, when gray-cheeked thrushes are migrating, have thus far led only to hermits.

Other ground notes less often heard, and perhaps less distinctive, are helpful at times.

I was once confident that I could distinguish olive-backed from hermit thrushes in flight by their frequently whistled, piping notes alone; it seemed then that among the earlier migrants in late August and early September there was a preponderance of notes slurred upward, and that these must have been uttered by the olive-backs which during this period became more numerous in the neighborhood. Indeed, on August 19, 1949, before migration had begun, an olive-back was seen back of Sandy Beach whistling softly and clearly the upward-slurring note more than 10 times in succession. Downward-slurred notes seemed more frequent in mid-September and were attributed to the increasing hermits.

Subsequent experience has weakened this assurance that dependable determinations can always be founded on the abundant pipes; both species slur both upward and downward occasionally. Furthermore, the gray-cheeked thrushes also appear to do so.

It was not until the evening of September 20, 1949, near Maria east of the Cascapedia River's mouth on the Bay of Chaleur, that another modification of these whistled, piping notes was recognized (p. 86). Among the clear, open, and often slurred calls that I had previously associated with hermits and olive-backs were more sharply emphasized notes somewhat metallic in quality. Some of them, though short, were distinctly stronger in the center, oÓo (or < O >). Another note heard at this time had an explosive inception, Óo, initiated by a glottal stop. It was ascertained in 1950 that both these notes are uttered as often by olive-backs as by hermits.

Greater reliance may be placed on other notes. Hermits, olive-backs, Bicknell's, and probably gray-cheeks, on the breeding grounds utter variants of *e-e-e* or *quee.* Once learned, these are detectable among the calls of migrants overhead. High, rapid, staccato *e-e-e-e* notes may be heard as the very earliest olive-backs pass along the shores of Gaspé Bay. These calls resemble those of the spring-peeper, the amphibian, *Hyla crucifer.* Similar notes, but in descending series, also occur. Accenting the first syllable and accelerating the rest alters the call into *ke-e-e-e,* rather musically rendered. Evolution into *ké-e-r, qué-e-arr, qué-e-arrt,* and shorter *quárrt,* all slurred downward, may be detected. These last approach the calls of Bicknell's thrushes but lack the harshness of this species, and furthermore, are heard on mornings of days that disclose many olive-backs but neither variety of gray-cheeks. At times olive-backs intersperse their *oop* flight notes with descending, clicky *e-e-e-e-e,* and strident, ascending *cre-e-e-e* calls of high range.

At dawn, September 23, 1948, one of several olive-backs that dropped to the steep forested slope beside the East Branch of the Ste. Anne River rapidly uttered a remarkable medley—a soft, short, whistled *o,* a higher *que-ee,* a sustained high, harsh *cre-e-e-ch,* ending with a repetition of the initial note.

Migrant hermits, among the common notes, utter now and then a mellow, vibrant *que-e-e* quite like their characteristic territorial note. This may be varied to *que-e-e-e-e,* the notes in descending series, more rapidly given than by the olive-back, and attaining a certain vibrance—not harsh as in the two gray-cheeked varieties. Another call, often used by hermits while feeding fledglings, may, on rare occasions, issue from a migrant in flight before dawn; it may be expressed as a short, high musical *plē,* of which the initial *p* is a slightly lower grace note.

All students of the Bicknell's thrush on its breeding grounds agree that its characteristic calls are variants of a downward slurred, veery-like *wheu,* or of *peert,* usually harsher notes than those of the olive-back. In migration I have recorded the calls of the gray-cheeked thrushes as, 1) a very high *pé-i-i-i-r,* more rapidly vibrant than that of the olive-back; 2) *peint,* of similar quality to the last; 3) *chéerrr,* sometimes explosive, and a gentler *whé-errr;* 4) *cheor, chéaw, chaw.*

Mathews (1921) writes, "The call notes of this mountain thrush are like those of the Veery but in most instances nearly an octave higher."

From his field notes on Bicknell's thrush Wynne-Edwards (in litt.) sends the following records:

> Mount Albert, (Gaspé), 24 June, 1932: "Sèe-ur"; also "whit" like olive-backed.

> Mount Washington, (New Hampshire), 23 May, 1936: clear "pee-ou" like canary or finch, besides the usual "whit." Also mewing like cats.

Langille (1884) ascribes to *bicknelli* breeding on Seal Island, N. S., the calls *cree-e-e-eep,* or *quea,* or *cree-e-e-e-e* on a rather high, fine key.

In late September 1948, several birds uttering "*cree-e-e*" notes passed down the Ste. Anne along the foot of Mt. Albert, and 2 such birds flew up the river, one of them following the East Branch. Possibly the northward-bound birds were Bicknell's thrushes from the Tabletop Mountains, while the 2 upstream migrants were the larger gray-cheeks from north of the St. Lawrence searching for an avenue southward across the peninsula.

Not heard by me are the more softly introduced *phea* and *phearr* and *frree-ook* notes as translated by other students of these gray-cheeked subspecies.

As a matter of fact, very little seems to have been recorded concerning the call notes of the gray-cheek (*H. minima minima*). Birds of this subspecies have been seen during migration through Connecticut and western Massachusetts. The only sound that is recalled from these was a low, catbirdlike "*wut,*" probably corresponding to the first call in the series recorded by Bent (U.S.N.M., Bull., 1949, 196, p. 195) as "*what, chuck, pheu* or *feé-a.*" During the thrush migrations through Gaspé, I have never succeeded in tracing a "*chuck*" note to a gray-cheek. All proved to be hermits. One would expect the calls of *minima* to resemble those of *bicknelli.*

Confusion concerning the ground calls of thrushes is likely to arise while trying to reconcile the varied written descriptions with notes issuing from "the bush." Having studied hundreds of olive-backs and hermits during the last 13 years, I am convinced that the former has never uttered in my presence a note that could be confused with the low "*chuck*" ("*tsuck*"), and that the latter never gave a note that closely resembled the characteristic, shorter *puck* (as in "buck"), *pook* (as in "book"), and *puckée* of the olive-back, or its higher glottally stopped *ook.* Some difficulty under certain conditions may be experienced in distinguishing between the clear musical *oo* of the perching or grounded olive-back and the usually weaker *O* of the hermit. Although some authors have ascribed a "*chuck*" of alarm to the olive-back, this sound has never been heard during the nesting seasons on the Forillon where olive-backs were common, and hermits unknown except as migrants. Furthermore, at Sandy Beach and in the forests of the interior where both species are abundant, *chucks* were heard frequently, and whenever traced, proved to issue from hermits.

One writer ascribes a similar *chuck* to the gray-cheeked thrush. No confusion of this species with the hermit is to be expected in the lowlands of Gaspé during the breeding season, for the gray-cheek is absent and Bicknell's thrush is locally distributed on the heights. But in the fall mistaken identity would be possible. With this in mind, no opportunity to trace the *chuck* notes has been lost; whenever the bird was seen it proved to be a hermit.

In my records the specific term, gray-cheeked thrush, does not necessarily imply designation of the subspecies. Geographically, migratory gray-cheek notes of the *"peint"* and *"cheer"* type have been recorded chiefly in the central and western parts of the Gaspé Peninsula. As noted above, in late September 1948 they were heard in small numbers passing both up and down the northward-flowing Ste. Anne River near its juncture with the East Branch among the Shickshock Mountains in the Parc de la Gaspésie. The following year, on September 19, *"peint"* and *"cheer"* calls were heard from 125 thrushes among a horde of more than 850 descending the Cascapedia River along the foot of Mt. Noble and its eastern twin, Mt. Berry (pp. 86–88). Farther northward next morning in the rain about 60 such birds descended the Brandy Brook Valley west of the Federal Mines. These harsh calls punctuated a multitude of whistled, piping notes ascribed to some 450 hermits. As dawn broke several birds descended into thick brush and woods. The fact that I was unable actually to find a single one of them after the light was strong enough for identification purposes, may be regarded as circumstantial evidence that these were either gray-cheeked or Bicknell's thrushes, notoriously difficult to approach.

Again, 5 miles eastward, on September 22, 1950, at the south end of Lake Ste. Anne, notes were heard at dawn from a group of Bicknell's or gray-cheeked thrushes feeding in dense young mixed growth (p. 127), and others in similar feeding environment beside the center of the lake at the foot of Mt. Sterling. In September 1951 they were again studied around the lake and on top of Mt. Sterling (p. 126).

It was surprising that no high *creech* calls were recorded along the Cascapedia and its tributary. Probably these notes, though characteristic of breeding *bicknelli,* are seldom uttered in flight.

Now Bicknell's thrush is known to breed in the higher Shickshock Mountains about Tabletop (Wynne-Edwards cited by Wallace 1939, Proc. Boston Soc. Nat. Hist., vol. 41, p. 244). These birds descending Brandy Brook southward may have originated in the Mt. Albert and Mt. Logan areas to the north and west. On the other hand, they may have been gray-cheeks from beyond the St. Lawrence that had ascended the Ste. Anne as in 1948, and had then crossed the divide into the watershed of the Cascapedia.

Observations on the 17th and 18th of September east of the Cascapedia at Bonaventure had disclosed only hermit thrushes in migration. It was very impressive, therefore, after the above outlined experiences near the headwaters of the Cascapedia at dawn (pp. 85–87), to find hundreds of thrushes flying southwestward on the evening of the 20th at Maria along the western side of the bay into which this large river empties. Sixteen of them uttered those same *"cheer"* and *"peint"* calls of *bicknelli* and/or *minima.*

It will be seen on the map (Fig. 3) that the mountains west of the lower Cascapedia descend to a plain some 2 miles in width that here borders the Bay of Chaleur. Within plain view the Carleton Mountains, rising abruptly for 1000 feet, continue the barrier toward the west. To the listener these 500–600 thrushes seemed to pour out of the Cascapedia Valley on their westward journey above this plain. An attempt was made by automobile to ascertain the numbers of birds skirting the coast east of the river's mouth, but an interpretation of the results demands caution. Upon my arrival at 9:15 P.M., a few hermits were still flying northwestward at X (Fig. 2). Unknown, of course, were the numbers that had passed this point earlier in the evening. With some confidence one might assume that they had been greater, for at Maria, when I started eastward, the evening's flight had already diminished from 10 birds a minute between 7:50 and 8:30 to about 1 per minute at 9:00. On the other hand none may have flown along the coast east of the river's mouth; all those heard at Maria may have come down the Cascapedia as previously assumed. The absence of gray-cheeks at X accords with the distribution of *bicknelli* in Gaspé; only a few are known to breed at Percé and Grande Grève, whence migrants would pass X, whereas they are suspected to be more numerous in the higher Shick-shocks north of the Cascapedia watershed. Scarcity of migrant gray-cheeks about Gaspé Bay should be emphasized. During six years of late September observations I have heard only 3 birds uttering the harsh "*cheer*" flight calls, plus 7 of the "*pearrt*" type.

In the western limits of the Gaspé Peninsula few observations have been made. At Routhierville in the Matapedia Valley during an unfortunate rainy period, a single gray-cheek call was heard among 5 birds that passed southward on the evening of September 21, 1949. Just before the following dawn such calls were lacking among 56 thrushes, supposedly hermits, that descended the Matapedia past this point.

In concluding this consideration of thrush voices on migration, the writer expresses confidence in his ability to judge the major complexion of flights as to relative numbers of three species of *Hylocichla*, namely, *guttata*, *ustulata*, and *minima*. He would not presume to distinguish between the two subspecies of *minima*.

While the average character of flight calls is well fixed within a species, many slight variations, both in pitch and quality, distinguish the voices of individual birds. The practiced ear detects many of them. They are very important in determining the number of thrushes passing at a given time, and also the direction of flight. The more individuals involved, the greater is the value of variants.

The frequency of utterance varies. Usually it is rather uniform for a given bird, but may be increased or shortened. For example, a hermit thrush flying a straight course down a wide valley piped at intervals of 13, 13, and 12 seconds. Then as it curved more and more sharply toward a hill-side upon which it was about to alight, the intervals were reduced to 9 and 6 seconds.

TIME DURING WHICH FLIGHT-CALLS ARE HEARD

Well recognized is the apparent tendency of nocturnal migrants to be more vocal during the earlier and later hours of the night. This is due not alone to greater likelihood of listeners being abroad at such hours, for not only have records been made by people whose occupational requirements provided favorable opportunities, but ornithologists have listened to them at various periods during the night, and through telescopes have observed birds crossing the moon (cf. p. 168). The question arises as to whether migrants fly from dusk to 10:00 or 11:00 o'clock, descend to rest, to resume flight during the hours preceding dawn, or whether they travel throughout the night, but are relatively silent during the midnight hours. Brewster's observations at the Lighthouse on Point Lepreaux, New Brunswick, revealed many warblers between 10:00 P.M. and 2:00 A.M. (Brewster, 1886).

One of the important findings by Lowery (1951), in his telescope studies of migrants crossing the moon, is that the greatest numbers usually pass between 11:00 and 12:00 o'clock. Occasionally the peak occurred as early as 10:00 o'clock and as late as 2:30. These results are the reverse of my records of flight calls in Gaspé, where the evening peaks with two exceptions—much less impressive—have passed before 10:00 o'clock, and the numerous morning peaks between 3:30 and dawn (4:00 to 5:30). One may reasonably question whether I was hearing at low elevations the early and late migrants, while Lowery was observing chiefly the mid-night birds that were flying above audible heights. But if this were true he and his collaborators should also have heard many call-notes during the evening and morning twilight hours. Further reference to this important paper appears on p. 168.

Whenever migrant thrushes have been heard in Gaspé during the evening, records have been kept either through the entire night or at intervals. On several such nights I was out of doors continually after 12:30 A.M. On the basis of experience here in the north, as well as at New Haven, Connecticut, both in spring and fall, it can be stated that flight notes of thrushes follow the above mentioned rule; they are heard in greatest numbers during the last hour before dawn. There is a notable increase within the last quarter-hour before the light becomes sufficient to bring the birds to the ground and render them visible. So infallible is this rule that good daily comparisons can be obtained by recording the number of migrants each morning during the half-hour preceding the moment when penciled

Time	*No. calls*	*Time*	*No. calls*
12:30–1:45	0	4:00–4:15	15
1:45–2:00	1	4:15–4:30	29
2:00–2:30	8	4:30–4:45	169
2:30–3:00	9	4:45–5:00	515
3:00–3:30	23	5:00–5:15	359
3:30–4:00	14	5:15–5:16	13

Table 1. Total numbers of thrushes recorded by their call notes during five mornings. Ninety per cent of them passed in the last half-hour of twilight.

figures become discernible in the field-book—about 0.01 f.c. (*See* Appendix) —and when most of the birds have passed or grounded.

In Table 1 are combined the flight calls recorded on five mornings, September 6, 7, 8, 9, and 11, 1948.

Curiously enough, comparatively few migrant thrush calls have been recorded during the early hours of the night—only 1221 birds in 10 seasons, all before 10:00 P.M. Experience having shown that the number decreased after this hour, efforts were directed toward the early morning. For the same years the combined morning totals were 32,700. The ratio of morning to evening migrants according to these figures was about 27 to 1. When large numbers are passing, the totals must, of course, be estimated. The exceptionally large flight at Maria on September 20 accounts for one-half of the evening total.

Date	*Thrushes*	*Date*	*Thrushes*	*Date*	*Thrushes*
Aug. 19	9	Sept. 1	494	Sept. 16	1115
20	0	2	157	17	153
21	3	3	308	18	144
22	13	4	915	19	1000
23	420	5	601	20	548
24	80	6	994	21	64
25	55	7	200	22	63
26	785	8	532	23	71
27	336	9	352	24	222
28	225	10	285	25	346
29	84	11	851	26	14
30	306	12	409	27	133
31	424	13	527	28	6
		14	453	29	0
		15	595	30	5

Table 2. Morning totals of thrushes recorded in flight during six years, 1940–41, 1947–50.

SILENT MIGRANTS

In the mind of one listening to migrant birds two important questions continually arise. First, are silent companions also passing? Second, will the birds heard at a given time and place become silent farther on? To the last query a positive answer safely rests on such observations as the following. At so favorable a location as Sandy Beach, where no barriers interfere, an approaching thrush may be heard 1500 feet up the bay shore, and nearly an equal distance as it recedes. It is, therefore, easily traced. But when another individual ceases calling abreast of the listener, absence of ground notes implies that the migrant continued in silent flight. Again, following an interval lacking notes, a thrush first pipes near at hand and continues as it withdraws. The mere presence of thrushes seen in the forest after dawn suggests, but does not prove, that they arrived silently, for they may have descended beyond ear-shot at dawn and subsequently advanced a considerable distance. These silent birds must be taken into account when estimating the numbers of migrants. The difficulty of assessing their numbers may be appreciated from the assurance that grouping does occur—probably as a general rule.

Confirmation of the belief that, judged by the uneven distribution of call notes, migrants travel in groups spaced at various intervals is furnished by my experience at Routhierville in the Matapedia Valley September 22, 1949. Single birds were heard at 5:09 and 5:26 A.M., 2 at 5:28, 5 at 5:29, 10 at 5:30–5:31, 15 at 5:33–5:35, and 20 during the next minute—the last birds heard in flight (Fig. 12). That these calls represented isolated groups —not merely vocal thrushes among a steady flight containing many silent birds—becomes evident from the distribution on the ground after dawn. This showed the same unevenness. I had been walking south from the village along the highway beside the river. Group after group of calling thrushes overtook me and passed out of audible range down the valley. The ecstatic ground notes at dawn were wanting in the vicinity where the descent deadline of 0.02 f.c. overtook me at about 5:40 A.M. Nor were any heard as I returned toward Routhierville until 5:47, when 2 hermits and an olive-back were encountered close to the hotel. Figure 12 explains this distribution.

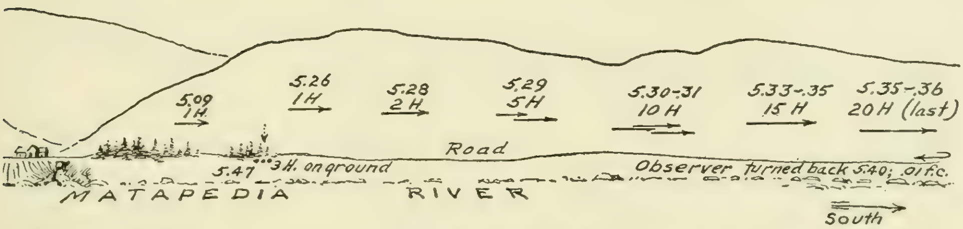


Figure 12. Migration and morning descent of thrushes in Matapedia Valley.

Considerable interest attaches to occasional isolated call notes. For example, at Sandy Beach on the morning of September 16, 1949, single thrushes were heard in flight at 12:40, 1:12, and 2:08. Each of them piped but once, demonstrating that these birds at times migrate almost silently. Probably others pass without uttering a sound. This is quite a different matter from hearing at long intervals individual birds, or small groups of them, that call frequently in flight. One feels some confidence that the latter are the only ones in the immediate locality at the moment, and that a void exists in the interval between these calls and others later heard. Under the latter conditions the number of calls closely represents the number of migrants, while under the former it is quite possible that additional birds are passing unheard.

Another possible explanation of the paucity of midnight call notes is that the birds are flying at too great an altitude to be audible. That this does not agree with much of the migratory behavior of thrushes in Gaspé will appear later.

MIGRATORY RESTLESSNESS

The work of Wagner (1930, 1937) on the annual and daily rhythm of migrants, and especially that of Siivonen and Palmgren (1936) on the effect of temperature, supplementing fundamental physiologic factors, on the induction of migratory restlessness in caged song-thrushes (*Turdus ph. philomelos* Brehm), aroused the hope that among summer resident birds in Gaspé, field evidence of such premonitory activity might be detected.

In addition to the flocking of juncos (*Junco hiemalis*), Savannah sparrows, and to a lesser degree white-throated sparrows, as they shift from breeding territories to autumn feeding grounds, certain instances of restlessness among thrushes were observed. For instance, during September 1 and 2, 1948, hermit thrushes, including second-brood juveniles in buff-spotted dorsal plumage, were still resident in their summer area on the plateau behind Sandy Beach. Olive-backs had been absent there since August 28. No evidence of hermits was found on the preceding cool morning of September 3. That most of these residents had left during the previous night seems probable from their absence on the following day as well. It is generally believed that from a given rather limited area the population of a species migrates as a whole at about the same date, different species departing under rather specific conditions.

This morning, September 4, was marked by the passage of about 50 thrushes along the bay shore and over the plateau. This first migratory movement of the year occurred 24 hours after the season's earliest frost in the low-lying areas. Three days of rain with easterly and northerly winds, and a fourth cloudy one, all with temperatures above 10°C. had preceded the frost.

Judging from their flight calls, the great majority, if not all, of these September 4 migrants were olive-backs; no hermits were identified by voice. Although none of the latter species could be found after dawn on the 3d, 2 were giving their ground calls at 5:00 A.M. on the 5th. These may have descended from the wave of 75 migrants that passed during the twilight period of this morning. It is certain that during the following seven mornings (migrants—150, 200, 475, 170, 150, 85, 50) new arrivals settled in this area, and into others along the bay. On the 11th some 40 olive-backs and hermits fed and rested for several hours in the brushy forest margin behind Point St. Peter, an area that previously had very few thrushes.

Little evidence of migratory unrest had been noted among residents of the Sandy Beach plateau before their supposed emigration after September 2, 1948. But new arrivals each morning showed the customary excitement associated with their descent.

In 1949, however, departure of thrushes from this plateau was not altogether unheralded. On August 10 and 11, hermits were on their summer feeding territories as usual, but on the 12th a group of 5 was moving about as though intent upon discovering new supplies of blueberries. Olive-backs also had been very quiet during their molting period, but on the 14th began calling again from small tracts of conifers distributed over the burn. Their notes were of the ordinary ground type, "*pŭk*" and "*pŭkee.*"

The first clear evidence of migratory restlessness was obtained at York Lake at dawn, August 17. The notes of olive-backs in the forest about the lake on the previous evening were of the sort just described, but on this morning 5 different thrushes repeatedly uttered from the ground clear piping calls such as soon would be used in migration flight.

Absence of thrushes on the Sandy Beach plateau on August 18 may indicate their emigration while I was at York Lake the preceding day. Certain it is that the first light movement of olive-backs occurred over this region at dawn on August 19; 9 birds passed southeast over the plateau. A single bird soon afterward uttered flight notes from coverts occupied by this species during the summer. No further records were obtained until the 23d, when 115 olive-backs coursed down the bay shore from sources west of Sandy Beach. Meanwhile, August 24 brought only 8 migrants, and the 25th none, but a great flight (650) passed out of the York Valley on the 26th. One hundred eight were recorded descending this valley at Big Fork on the 27th. Seventy olive-backs passed Sandy Beach and Haldimand on the morning of August 28. Later, at 9:18, a bird of this species piped clearly from its resting place in a grove of spruces at the brink of the shore cliff beyond cultivated fields. On the two following days, though no movement was detected, 2 or 3 olive-backs uttered similar flight notes from the coniferous woods at Haldimand. From the identical area, birds believed to be the same had been heard on several mornings earlier in the month. At that period the calls were of the "*pŭk*" type; whereas two days later a succession of upward slurred, clear notes, and rising series of staccato syllables strongly suggested migratory restlessness.

Migratory unrest is difficult to observe among wild birds. It is questionable whether this is the behavioral state of the flocks of robins that gradually accumulate in September on such areas as the Sandy Beach plateau. Each morning from 50 to 200 birds may be found there just after dawn. One sees them fly from their night roosts in the conifers to the blueberry patches in the burn. Frequent notes of remonstrance toward new arrivals are heard, and noisy chasing takes place among them. At times the noise rises to a veritable din. But this activity seems as great in mid-September as it is in October on a morning when the flock leaves on its southeastward migration. In other words, the pipes and short flights during the preceding period may signify nothing more than high spirits of the "gang."

Typically, then, migrant thrushes' flight-calls in Gaspé, as elsewhere, are far more numerous within the hour before dawn. Rarely, as at Maria, evening activity is strong. The same is true in southern New England; P. G. Howes' statement (1914) that the olive-backs passing over Stamford, Connecticut, continued piping throughout the night may not have been based on continuous observation. One hearing birds in flight in the evening and again at dawn may easily gain the erroneous impression of unceasing nocturnal migration.

As stated earlier in this paper, very few calls can be heard during vigils between 11:00 P.M. and 3:00 A.M. Either few thrushes fly during mid-periods of the night, or they fly silently at times (cf. p. 56). The evening flight notes at Maria were uttered only from 7:35 till 9:15 P.M. Next morning only 8 thrushes called in flight. These 550 vocal evening migrants are regarded as a group that had left the lower half of the Cascapedia Valley, rather than as part of a continuous flight of thrushes that called only during the early evening. This is not to say that those thrushes did not call as long as they were in flight, nor how far they flew. Inception of flight doubtless results from one set of stimuli; cessation from another set. In other words, a thrush once launched from the ground at 7:30 P.M. may conceivably fly continuously till dawn, uttering call notes chiefly near each end of the journey. Again, it may continue to call, say on intensely moonlit nights. For example, 5 olive-backs were heard at Sandy Beach September 5, 1949, between 12:34 and 12:52 A.M., and another at 1:36 A.M. They may have been in flight since early evening, or may have risen but a short time previously.

Experimenting with caged song thrushes (*Turdus ericetorum philomelus*) and European robins (*Erithacus rubecula*) Palmgren (1944) observed that migratory restlessness usually arises after an evening sleeping pause, and declines before midnight. These birds sometimes showed it after midnight or early in the evening. Occasionally several periods, or two maxima, occur during the night. Palmgren found that migratory unrest may even appear during the day. In partly captive rose-breasted grosbeaks (*Pheucticus ludovicianus*) Ivor (1944) found that as each migratory season approached they "showed a decided restlessness, flying from perch to perch in the aviary all night."

To the long known fact that different species of nocturnal migrants are first heard not earlier than rather definite hours in the evening, Drost (1931) added records on Helgoland of the passage of the dunlin (*Calidris alpina*) from one to seven hours after sunset. During the spring migration the first notes heard each night were assumed to have been uttered by individuals departing from the island, while later ones had flown some distance. Similarly in late summer and autumn the first notes were recorded not earlier than two hours after sunset in July and early August, and one and one-half hours in September—November. From our standpoint his records of a European thrush known as the blackbird (*Turdus m. merula*) are important. In its spring migration, with two exceptions, no individuals passed before a quarter-hour after sunset and, interestingly enough, none later than one hour. Drost concluded that the intensity of light determines the daily departure of birds.

The evening flight period shown in Drost's graph of *merula* records is of even shorter duration than has been found in the case of Gaspé thrushes. The greatest evening migratory movement was observed at Maria (p. 86). Whereas, on the basis of call notes, most other flights during the early hours of the night, though consisting of fewer *Hylocichla,* extended over periods from two to four hours in length, this exceptional flight that left or passed the mouth of the Cascapedia River began at 7:35 A.S.T., 25 minutes after sunset and ceased at 9:10 (Astronomical Twilight ended at 8:44). This period was about twice as long as that of *merula.*

These data of Palmgren and Drost and other observers strengthen our belief that not all Gaspé thrushes *begin* their flight during the same period —that ordinarily few rise during the evening, many during the late night hours. On rare occasions, as at Maria, early restlessness was common to a large number. The comparatively few thrushes heard between midnight and 3:00 A.M. may have taken flight at the onset of restlessness at various hours. As shown in the following paragraphs, the beginning of migratory flight in early morning, and during the night, as well as in the evening, has been confirmed in Gaspé.

Wolfson's (1942) experiments in delayed migration appear not to support Bissonnette's generalization that birds are stimulated to migrate while their gonads are recrudescing, and are induced to stop migrating when recrudescence reaches a certain point. For Wolfson found that although juncos were detained on the wintering grounds, where the gonads attained breeding condition, they did not breed when released, but were presumed to have migrated. Castrated birds also migrate (Hann, 1939). Even before the gonads recrudesce, tree swallows (*Iridoprocne bicolor*) arrive at Ottawa, Canada, as early as March 28 (Eifrig, 1924). Wolfson believed that the important effect of pituitary change is not recrudescence of the gonads, "but production of a physiological state that will enable the bird to meet successfully the energy requirements of migration." Migratory restlessness supposedly would be one of the manifestations. Van Oordt (1943) suggested that birds can be stimulated to migrate by environmental factors only after they have entered the *Zugdisposition* phase, brought on by an internal physiologic rhythm.

Rowan, as Bissonnette (1937) points out, was the first of modern experimentalists to attribute to change in the length of day the autumn regression of the gonads which causes the restlessness that leads to southward migration.

Restlessness may be due to lowered thresholds to stimulation by external environmental changes other than light. Disturbances such as steep rise or fall in temperature, strong wind, and heavy rain, or more incidental ones like the movements of an observer, may arouse a bird into flight (p. 65). The belief has been expressed that thresholds are lowered by the decrease in the secretion of pituitary hormones which characterizes the refractory period. It has been shown by A. H. Miller (1948) that in the golden-crowned sparrow it is not the testes that are refractory to stimulation by the gonadotropins secreted by their pituitaries, but rather the pituitaries themselves. Excellent reviews of modern work on photoperiodism in birds were written by Bissonnette in 1937, and over a decade later by his collaborator, Burger (1949). The latter sees no evidence that reproductive rhythmicity occurs independently of controls in the external environment;

what is known of the avian pituitary indicates that external environment controls this organ, at least to some degree.

Marshall (1951), seeing no evidence that the anterior pituitary is autonomous in its activity, and basing his conclusion in part on his refined studies of testis histology, evolves a possibility into the conviction that an internal gonadal rhythm is the most important single factor in timing breeding seasons as well as the associated migrations. Far from ruling out external influences, he reviews important evidence, from Arctic to Antarctic, and especially from Australia, that sun, rain, or availability of nesting sites and abundance of food are the factors determining the time of ovulation. This may well prove to be the most valuable contribution in his paper. It may be noted that Marshall refers only to migration to the breeding grounds.

As Farner (1950) points out, while observations have been recorded by many writers that various species of birds migrate under potential external stimuli of one kind or another, there is actually no indication whether migration would or would not have occurred in the absence of the stimulus.

If, as Bullough (1945) and others believe, absence of gonadal hormones is the stimulus to fall migration, how are we to conceive the birds' sensitiveness to his environment? Does absence of hormones change its thresholds of reaction to external stimuli, or release dormant tendencies? Much safer is Wolfson's (1945) opinion that the entire physiologic and psychologic state of the bird contributes to the migratory urge; the actual control of the resultant behavior resting upon the nervous system. Kendeigh (1934) expressed much the same opinion, and suggested that decreasing metabolism in autumn, through hormone withdrawal, may sensitize the bird to lower temperature.

On the other hand, we have the important observation by Rowan (1929) that just before and during the southward migration of juncos their gonads exhibit a second burst of interstitial cell activity. This recrudescence, if confirmed, would account for the autumn migration by the same mechanism believed to cause the northward movement in spring. However, experimenting on caged redstarts (*Phoenicurus phoenicurus*) Schildmacher (1937) found that additional light in September, when migration should occur, produced no visible effect upon the gonads, but that such treatment after November 12 caused some testis growth accompanied by a decrease in restlessness.

Many students of the physiology of migration agree that spring movement occurs while the gonads are recrudescing, and have been doing so for some time. Furthermore, strong evidence exists that failure of gonad growth in spring results in failure to migrate (dunlin, knot, turnstone, Van Oordt, 1928, 1931 [cf. Bullough, 1945]; gannet and pomarine jaeger, Wynne-Edwards, 1939; purple sandpiper, Bullough, 1942). Partial migration may be due to partial recrudescence of the gonads, common in immature vertebrates in spring.

According to Bullough (1945), in the autumn extreme regression releases birds to migrate. Even in a strictly sedentary race, the British starling, he states that juveniles with inactive and minute gonads wander hundreds of miles during their first summer. We may then infer that in other species whose immature birds migrate before the adults, their gonads are in this inactive condition. On the other hand, in others whose young migrate after the adults, the young may have undergone a temporary gonadal growth that prevented their earlier migration. This seems unreconcilable with Rowan's observation of fall migration with increased gonadal activity.

Bullough (1945) writes that when autumn migration time approaches birds become extremely restless, even to the point of sleeplessness at night. He calls this restlessness the "migratory urge."

Let us examine this urge. How does the bird actually feel, and why? In the first place restlessness cannot be due to hunger, for it begins early in the evening. Nocturnal and early morning restlessness observed in Gaspé thrushes might be intensified by hunger due to the lengthening hours of darkness since the last feeding period. Wagner (1937) found that sparingly fed birds were much more restless at night than well fed ones. Probably, however, in thrushes and other nocturnal migrants the same cause acts throughout the night. This cause has been attributed to absence or very low secretion of hormones.

Noble (1931) regarded the development of sensitivity in amphibia toward certain external stimuli as controlled by seasonal hypertrophy of the gonads, which in turn are under hormonal control, especially by the anterior pituitary; and held the final factor of the migratory impulse to be a climatic change—land and water temperatures, sudden increase in humidity, especially heavy spring showers. Beach cites Reinke and Chadwick's belief (1939) that the substance responsible for appearance of the "water drive" in the terrestrial phase of *Triturus viridescens* "is similar to the growth hormone of the anterior pituitary."

Bullough and others have suggested that the absence of gonadal hormones in autumn at least does not prevent migration. Schildmacher purports to have shown that the strong migratory urge shown by birds at this time can be eliminated by injection of hormones. Both Bullough and Beach point out, however, that no real proof exists that Schildmacher's birds did more than disappear.

If we grant that thrushes and other species migrate northward under the influence of an anterior pituitary hormone, acting through sensitization of exteroceptors to light, temperature, etc., in spring, how are the birds stimulated to migrate *southward?* Does absence of the "spring" hormone sensitize the same exteroceptors to weak stimuli of the same sort or to their absence? Or does the pituitary secrete in autumn another hormone that sensitizes them? Harking back into racial history, may the absence of a hormone (which causes "northward drive" in spring) in autumn release the bird to seek its old southern home? This brings to mind the concept of "innate rhythms" and tendencies. Bissonnette (1937), Farner (1950), and others recognize the evolutionary background.

In trying to understand how endocrines may effect migration we may turn to Beach's final chapter (1949) and observe his cautionary statement "that a given hormone or combination of hormones may condition several different behaviors each in a different manner. For example, it is possible that gonadal hormones exert important influences over both migratory and reproductive responses in particular avian species; but there is no reason to assume that the effects are mediated by one and the same physiologic mechanism." Every behavioral response is a reaction of effector mechanisms to internal and external stimuli, in which the chemical nature of the internal medium is involved. Many opinions have been expressed as to the specific nature of the hormonal action upon neural tissue.

One method considered by Beach is the control of periodic growth and regression of nervous elements; for example, the annual migratory behavior of birds might be due to cyclic growth and regression within specific nerve tracts and centers. He agrees with Lashley (1938) that supporting evidence of this possibility is not yet available, but points out that "extensive growth need not be postulated to account for the type of behavioral change with which we are concerned"—establishment of new synapses, for example. This idea might be employed to explain by nerve growth and functionizing of synapses the northward urge in spring, and by regression of these nervous units the release of the bird for return southward in autumn.

But Beach favors the more widely accepted theory "that the glandular products, instead of directly increasing or decreasing nervous activity, act upon critical nervous mechanisms in such a way as to alter their responsiveness to external stimulation." Kendeigh (1934) suggested the possibility that migration in some birds may be due to endocrine changes that sensitize the nervous system to environmental stimuli. Possibly Woodbury (1941) had in mind the pituitary hormones when he expressed the probability that any endocrine activity involved in migration is independent of the gonads. Bullough (1942) in his paper establishing the presence of two races of starlings in Britain during the winter, recognized clearly the different internal reproductive rhythms in the British and Continental birds. This difference he tentatively attributed to the pituitary gland. Beach (1949) himself suggests that hormones lower thresholds of nervous mechanisms in which mating patterns are organized. In applying this thought to migration (a part of reproduction), we may conceive the lowering of the threshold of the nervous mechanism for taking up of territory and its sequelae in spring; in autumn the absence or deficiency of the hormone might allow the threshold to rise, and permit other nervous mechanisms to assert their influence in returning the bird to its southern racial home.

As to the way in which stimulation, inhibition, or alteration of nerve cell sensitivity is effected, Beach points to the obvious method of modification of the production of specific enzymes involved in nerve activity. He then cites studies which have traced the relation of choline esterase to the metabolism of acetylcholine, and of the latter to synaptic transmission and the control of excitability in the nervous mechanism (Sawyer, 1943). Beach finds insoluble on present knowledge the problem of explaining how the introduction of a diffuse chemical substance, the hormone, into the blood stream could result in the highly selective stimulation observed, but he offers a promising possibility (Beach, p. 273, 1949).

VISION AND NOCTURNAL MIGRATION

It is desirable to present some evidences of avian powers of vision at night and their relation to nocturnal migration.

If one believes with Walls (1942) and Pumphrey (1948) that night vision of such birds as thrushes is poor, one may doubt their ability to find their way safely down to a perch or to the ground. He must, therefore, believe that after once taking flight in the evening the birds remain aloft all night. As already explained this conclusion is believed to be unnecessary, at least in the case of thrushes. Upon a number of occasions while I was engaged in night studies a bird has been suddenly awakened among evergreen branches. With no more audible confusion than evinced by the striking of a twig or two with its wings, each has succeeded in finding another perch within the distance of a few yards. At 9:40 P.M. August 1, 1948, when starlit sky rendered tree masses discriminable from open bracken, a male made a relatively long flight when roused from his territorial roosting tree in a clump of spruce and birch. He crossed an open area in the burn, passing above the tiny fir beneath which his mate was incubating, and alighted successfully in a fire cherry. Thence he was again flushed and perched in a spruce 20 feet away. This apparently was accomplished as easily as he often did it in the daytime when watched from a blind erected a few feet from the nest where daily studies were being made.

Although familiarity with his territory may have aided this particular bird, his behavior furnishes striking confirmation of the ability of this and other species to find their way about at night when necessary. Whether one shall deem necessary the descent of migrant thrushes at night in Gaspé is, of course, another matter. In the light of the above experiences, strengthened by others with white-throated sparrows, juncos, and grouse in Gaspé, as well as a catbird, towhee, and other passerines in Connecticut, I believe that, to a thrush that had been in flight for several hours, "necessity" need be no more stringent than a moderate sense of fatigue. But as far as known no records are available of passerines actually seen or heard thus ending a migratory flight.

Not infrequently while following paths through brushy pastures in New England and Gaspé at night I have startled passerines from their nests and roosts. Aside from momentary fright none of them seemed to have any difficulty in escaping. More than once such a bird has certainly found near by another perch from which to utter notes of alarm.

Careful observation of nesting Bicknell's thrushes by Wallace (1939) revealed that the incubating females frequently leave the nests before dawn "when it is still quite dark."

Consider the ovenbird (*Seiurus aurocapillus*), which at midnight rises through the trees of our New England forests to begin above their canopy his remarkable nocturnal medley, completed as he descends—apparently to his original perch near the ground. Song sparrows (*Melospiza melodia*) sing sporadically before morning twilight (Nice, 1943; Ball, 1945). These and other such instances lead to the belief that ability to see fairly well at night is not confined to the so-called crepuscular caprimulgids, herons, waterfowl, shore birds, and others that habitually feed at night.

Interesting in this connection was the behavior of thrushes migrating past Sandy Beach at dawn, August 24, 1949. From 4:32 to 4:45 at a light intensity below 0.001 f.c., all followed the shoreline, but at 4:52.30, 4:54, and 4:54.30 the last 3 birds passed from above the shore obliquely over the hill toward the St. John estuary. It was then light enough (0.004 f.c.) to distinguish bushes and paths in the "burn." This shift up the slope and across the plateau has proved to be the rule. Without doubt birds already awake and at the end of flight should excel in vision a suddenly awakened one.

Students of the physics and physiology of birds' eyes should note the activity of passerines feeding at dawn. While the light intensity is still below 0.001 f.c. sparrows in autumn fairly crowd sections of earth-surfaced country roads. One sees them fly up ahead of his automobile (headlights dimmed) and alight again a few yards beyond. A dozen may be in sight, all pecking at the road surface with the greatest diligence and apparent assurance that they actually see the tiny objects of their search. That these include not only sand grains but insects is indicated by the rapid dodging of the birds in brief pursuit of moving prey. Nor is this activity to be explained as opportunism in the artificial illumination afforded by the automobile lights. For after these are extinguished, the birds continue, as may be ascertained by use of "night glasses."

Not only fringillids but robins and even thrushes have been seen thus feeding on the road in earliest dawn. Although man cannot discern insect movement there or distinguish individual grains of grit, these birds easily succeed. If their vision at 0.001 f.c. is better than man's I believe it also exceeds his at the low intensity in which thousands of birds conduct their annual migratory flights. We must not, however, give undue weight to the ability of ducks, herons, owls, and caprimulgids to feed at night. As Pumphrey (1948) and others have said, the auditory sense is probably of prime importance to these birds in apprehending their food.

It is worth noting that, like owls and goatsuckers, the eye of an old-world thrush, *Turdus merula,* has a small pecten (Wood, 1917). This may be correlated with the behavior of thrushes; more than many passerines, they frequent environments with reduced light intensity, and so have a reduced "rate-of-living of the sensory retina" (Walls, 1942). This is not to say that the pecten is directly concerned with better nocturnal vision in birds.

As Williams (1950) has recently shown so clearly, migrants at times may be overtaken by, or carried by air masses into areas of invisibility—rain, snow, fog—and there suffer disaster when driven against objects while attempting to land, or while falling wet and exhausted. But we are here concerned with thrushes migrating under meteorological conditions that are favorable, or at least not such as to cause hardship. In ten years' experience the only fatalities from collision among Gaspé birds that have come to my attention have resulted from contacts with wires and automobiles.

That among passerine birds thrushes rank high in ability to see at night may be judged from the late hour at which evening song ceases, and the earliness of its morning inception. In Gaspé, where evening twilight ends later than in New England, hermits and olive-backs in late June sing until after 9:45 P.M., and Bicknell's thrush until 10:00. In the morning hermits begin as early as 3:20 A.M. Although these hours fall in the twilight period, no other species were singing at this low intensity of light. Wallace (1939) found that Bicknell's thrush stopped all activity on Mt. Mansfield, Vermont, at about 8:30 P.M. in mid-June—some 350 miles south of northeastern Gaspé.

DEPARTURE FROM GROUND AND DISTANCE FLOWN

Having found no American records of the actual nocturnal departure of passerine migrants from their feeding territories, or of descent from flight during the hours of darkness, these phenomena have been kept in mind during the Gaspé studies. As yet no examples of descent before the dawn twilight have been obtained, but a few instances of departure have been witnessed, and are recorded here.

At 7:50 P.M., September 10, 1941, near the intersection of Madeleine Fork with the York River, the shadowy forms of 2 or 3 hermits were seen flitting to and fro among low bushes uttering their characteristic ground notes. Five minutes later they sprang up and away to the eastward down the valley. The notes that then came back were clear flight calls; these birds had started their migration, or at least one stage of it—perhaps the first. Another evening departure was recorded at Sandy Beach, 6:53 P.M., September 18, 1950. Again, while standing quietly, listening for migrants, in a path through shrubs and scattered trees on the low hill behind Sandy Beach, September 6, 1949, my attention was suddenly drawn to a clump of spruces 30 feet north by the ground note of an olive-backed thrush. The first note (*puk*) was uttered at 2:16 A.M.; during the next four minutes it was three times softly repeated. At 2:22 the bird gave a double note, and after a few seconds another single *puk*. The next call, at 2:23, was entirely different—the typical migratory note—and came from a distance of some 75 feet to the east. That the thrush had taken flight was confirmed by three more single notes receding into the distance southeastward, as well as by the cessation of ground calls. It should be emphasized that this is the direction followed by thrushes in their migration over Sandy Beach toward the mouth of the St. John River. The significance of this instance in relation to the problem of orientation is deferred for later consideration. In the present connection it is to be noted that about three hours of flying time were available to this thrush before dawn.

A similar early morning occurrence was witnessed September 7, 1941, at York Lake on the headwaters of the river. Near the outlet in an area partly cleared of forest a single hermit's ground call was heard at 3:46 A.M. No migrants were passing; therefore the next sound, a typical flight note uttered at 3:48 A.M. from a distance of some 200 feet downstream, and instantly followed by a second note of slightly different pitch and quality, indicated that 2 thrushes had left the ground. Five or six seconds later these calls were repeated farther down the valley, thus confirming the direction of flight as south-southeast.

While interpreting these instances as departure of migrants one must recognize two possibilities. First, the birds were rising, not from summer territories as postulated above, but from nesting and feeding grounds recently entered either from near-by areas, or from distant ones. In either case—certainly in the second—the birds had already begun migration.

Somewhat less than two hours of flying time remained for these birds. In the first of these instances the thrush leaving Sandy Beach, if it continued along the coast, could have flown at least 75 miles. This would have put it down at dawn in the vicinity of Port Daniel. If, as assumed, the second pair followed rather closely the course of the York River, they would have been overtaken by dawn near the head of the estuary.

These observations, then, assure us that not all migrant thrushes make nearly the maximum flight possible during a single night. It is of interest that some of these birds departed late in the night. One might have expected that, to a thrush whose threshold of migratory irritability had been attained, the onset of darkness on the previous evening would have served as the release for flight. The meteorological conditions were as favorable then as at 2:30 and 3:45 in the morning—cloudless and nearly calm in the first instance; partly cloudy with light west wind in the evening, fair and cool at the hour of departure in the second case.

They also tend to confirm the earlier deduction that thrushes heard passing out of the lower ends of the valleys before dawn, or descending to the ground at dawn, had left higher parts of the same watersheds not many hours earlier. It may be recalled that in only a few instances have thrushes been heard ascending valleys.

Call notes prior to dawn usually begin only after the increase in twilight intensity is appreciable to the human eye (estimated at 0.00002 f.c., not detectable on Photrix photometer). These first calls are almost invariably those of single birds, flying at considerable intervals. Are they accompanied by silent companions, or may they be advance migrants from localities that furnish the later and more numerous arrivals on a given morning?

Possibly the latter have a higher threshold of light sensitivity in relation to utterance of flight calls, and others like them may have been passing for hours in silence. If light intensity is not the stimulus, some other must be operative. Perhaps the distance traveled, or the time employed, or especially the energy expended, may be concerned; those birds that have been in flight longer may be the earliest to call in response to the first visible increase in light intensity, and its suggestion of food soon to be found, while the majority, having begun their flight later, perhaps at an intensity equal to that at which other thrushes take flight in the evening hours, are less hungry and hence become vocal later at a greater intensity of light.

It may be remarked that this use of only part of the night for migration helps to account for the rather slow rate by which a species moves southward. Until someone records the descent of passerine migrants during the middle hours of night, or the not distant recovery of banded birds, the hour of whose departure is known, we cannot prove that some of those heard rising in early evening fail to continue until dawn. As suggested earlier in this paper (p. 57), the dearth of flight notes heard at a given point during "the dead of night" may as well support this supposition as the other alternative, namely, that the earlier starting migrants have already passed the observation post and continued on their way. At the same time it encourages hope that such descent sometime may be witnessed.

It has been stated by some observers that ordinarily migration does not occur on very dark nights. Experience in Gaspé in part supports, and again denies this affirmation. It is true that no migrating thrushes have been heard during midnight hours when the sky was heavily overcast. But they certainly have been recorded in appreciable numbers on a few cloudy mornings as the dawn light became sufficiently intense after the night's darkness. This was true of both heavy migratory movements on the Cascapedia, September 19 and 20, 1949. Rain fell intermittently on the former, while the latter was cloudy. Again, heavy showers occurred even after migrants began passing at Mississippi Brook in the York Valley at dawn, August 29. If birds in general remain grounded during the mid-hours of dark nights, these instances of migration at dawn may be cited in support of the thesis that, in extreme cases, inception of flight may be delayed until shortly before dawn.

Obviously, since thrushes never continue flight after light has attained an intensity of about 0.05 f.c., such late starting birds can make only relatively short flights. Unless they compensate by undertaking longer ones on other nights, their southward journey will require a longer period than is ordinarily conceived. Stresemann (1944) concluded that the black-headed bunting (*Emberiza melanocephala*) migrates at the rate of 1000 kilometers in seven days, of which two nights may be used for flight, five for sleeping, and seven days for feeding and resting. This would require long periods of flight on the two nights devoted to migration. Allowing ten hours per night the birds must have maintained a speed of 50 kilometers (31 miles) per hour. Probably the necessity for so many hours of nocturnal flight was reduced by slow, drifting progress during the assumed days of rest. Floerike (1928) assumed the actual flying time for most birds to be not more than eight hours per day, while the stork rarely exceeds four hours.

Such a leisurely schedule as this would allow Gaspé thrushes to reach Boston, Massachusetts, within a week (880 kilometers direct). If they followed the coastline, distance would be increased according to the exactness with which they traced the shore. Overland cut-offs would reduce the distance considerably, but not necessarily the time consumed.

That hermit thrushes on the average use nearly a month in slow travel from the latitude of Gaspé to Boston gains probability from a comparison of the dates of greatest abundance in the two regions during the autumn migration (Fig. 13).

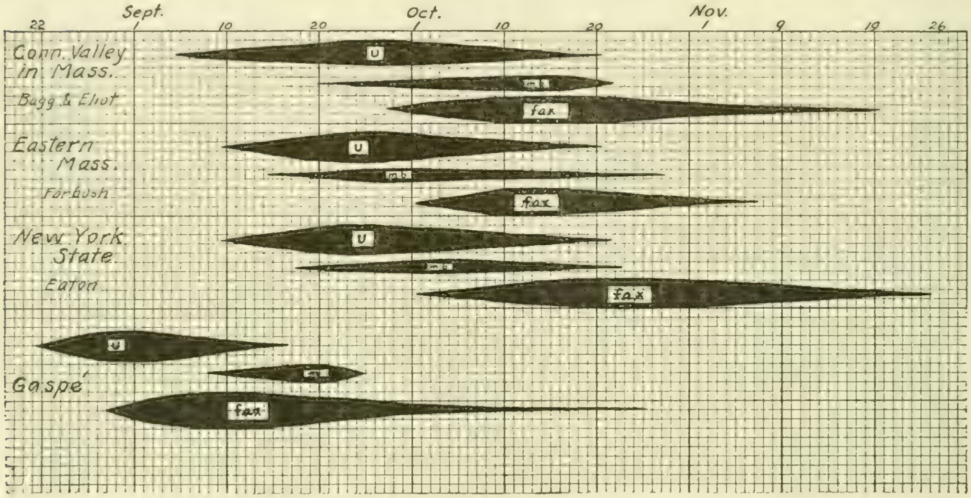


Figure 13. Graphs of thrush occurrence in New England and in Gaspé. Fax = hermit, m = gray-cheek, mb = Bicknell's, and u = olive-back.

From Campbellton at the head of Chaleur Bay, near the point on the southern Gaspé coast where thrushes must surely leave the peninsula, the air-line distance to Boston is approximately 500 miles. Judging by their behavior in Gaspé none would fly so direct a course. Should they follow the coast of the Maritime Provinces, omitting Nova Scotia, they would travel 690 miles. Circum-migration of Nova Scotia as far as its southern tip would add 580 miles and necessitate a flight either across Massachusetts Bay, or more probably back northward along the Fundy coast. Many partially reverse their course rather than cross the narrow Gaspé Bay; and similar behavior has been reported northwest of Cape May along Delaware Bay (Allen and Peterson, 1936). Inspection of the map may admittedly raise doubt as to whether consideration should be given to such a roundabout course as the outer coast of Nova Scotia would require. But

Gaspé experience demands that field observations be made before discarding the coastal route—a maximum of about 1550 miles (2480 kilometers). This adds further interest to the time interval of a month between dates of greatest numbers of migrants in Gaspé and in the vicinity of Boston. Caution in applying this measure is suggested by almost simultaneous maxima in Boston, Northampton, and central New York. For the source of these birds is unknown; some doubtless use the coastal lines of the Atlantic flyway, while others come southward through New Hampshire and western Maine. The fact remains that much less than one month would be required by thrushes migrating at Stresemann's rate of 1000 kilometers per week by the black-headed bunting.

DATES OF THRUSH MIGRATION

The earliest date of suspected migrant thrushes was August 18, 1947, when 3 olive-backs passed southwest over the hill behind Sandy Beach at 4:47 A.M. In 1948 a single flight-call was heard at 2:05 A.M., August 26. A second flew over at 4:51 and a third at 4:58. Another August migration began with 6 olive-backs on the 19th in 1949. That this was to be an "early season" became evident when 115 passed on the 23d, 650 on the 26th, and 108 on the 27th. Smaller flights were recorded on the last four days of the month. In 1950 migration began at nearly the same date, August 21—again with 6 thrushes. These low numbers early in the season suggest the probability that even earlier a few migrants may pass unnoticed.

The first undoubted migration occurred on September 5, 1940, 1941, and 1948; on the 8th in 1946, and the 9th in 1947. Thereafter, as appears in Table 3 and Figure 13, the numbers increased until the 15th. A lesser peak occurs in some years around the 24th. It is possible that the second node represents an increase in gray-cheeked thrushes. Olive-backs predominate during early September, but still pass in some numbers late in the month. Although hermits accompany the first olive-backs, their greatest flights occur later and continue in much lessened volume until November 1. Several were seen on the ground October 25, 1941.

MIGRATION IN NORTHEASTERN UNITED STATES AND GASPÉ

In the northeastern United States the seasonal occurrence of migrant thrushes, chiefly seen in daylight, has been recorded by many ornithologists. Figure 13 combines graphically the reports for many years given by Eaton (1909) for New York State, Forbush (1929) for New England, and Bagg and Eliot (1937) in the Massachusetts portion of the Connecticut Valley. Very apparent is the overlapping succession—olive-back, gray-cheek (*minima* and *bicknelli*), and hermit. Disregarding for the moment the possible origin of the birds, these graphs agree in recording the earlier migration of the olive-back, especially in New York. The coincidence of gray-cheeks in all three areas is very close. Hermits in New

York and New England move southward together later; the apparent earlier cessation of this species in central Massachusetts may be partly due to its smaller area. On the whole the spread between the species is greater in New York, the first olive-backs arriving more than a week earlier than in New England, while hermits appear simultaneously in the two areas.

Borror (1950), on the basis of more than 30 years' records by many observers, gives the average autumn arrival and departure in central Ohio as: olive-back September 5—October 13, gray-cheek September 5—October 4, and hermit thrush September 28—November 3. In southeastern Pennsylvania Middleton (1939) by trapping found migrant thrushes remaining from 2 to 12 days—the majority 4 days or less.

The data available from Gaspé show the same order of appearance for olive-backs and hermits, but an earlier migration, as would be expected (Fig. 13). Gray-cheeks, however, seem more closely associated with hermits; none has been found before hermits have begun their movement. It is to be emphasized that, as yet, little field work has been done in central and western Gaspé until after mid-September. The paucity of gray-cheek records in the eastern part of the peninsula undoubtedly reflects the small size of the resident population there, while lack of early records in the western half may be canceled by projected studies there during the entire migration period.

In their order of appearance during migration through the northeastern United States (Bagg and Eliot, 1937; Eaton, 1914; Forbush, 1929) the gray-cheeked thrush is intermediate between the olive-back and the hermit. There is, however, much overlapping. Figure 13 illustrates the distribution by dates in Massachusetts and New York, based presumably on birds seen during daylight.

In Gaspé, if one may judge from experience in 1940 and 1941 when observations were carried on until after November 1, hermits from the north doubtless continue to migrate through Gaspé in small numbers throughout most of October; 4 left the Forillon on October 18, 1940, and 7 were seen at Seal Reef October 25, 1941. In later years I have left Gaspé earlier, September 28–30.

The observations recorded above lend further support to the conclusion that the thrushes heard migrating down the valleys and along the shores of northeastern Gaspé during August and September are residents of this region just beginning their southward flight. Had a considerable proportion of them come from areas north of the St. Lawrence, gray-cheeks should have been detected among them. The Bicknell's thrushes recorded as migrants in this region included a bird taken in the lower part of the St. John Valley October 2, 1941, and several heard September 27, 1950, among the birds (cited above) at the divide near the head of Second Fork between the St. John Valley and that of Grand River. In the central part of the peninsula not less than 125 of the 850 thrushes that passed down the Cascapedia on September 19, and a number of those heard next morning along Brandy Brook, were judged by their notes to have been of the species *minima.* It was suspected that they were *bicknelli* from the higher Shickshocks, known to be one of their breeding areas (p. 48 et seq.).

FLIGHT-LINES OF THRUSHES IN GASPÉ

NORTHEASTERN GASPÉ

Unless otherwise indicated the following statements are based upon data derived from nocturnal flight-calls.

Thrushes enter the Forillon from the northwest at the Break (Fig. 4); a few of them pass through the Grande Grève gap and out over the bay toward the south shore, possibly attaining it. The rest curve left down the Forillon either above the central coulée or the bay shore. Others come down over the west highlands, and still others along the southern slope. Many return to the northwest, following the shoreline rather closely to Little Gaspé, as "narrow-front" migrants.

At the tip of the Forillon such night records as have been made show a few birds flying out over the water as though to cross the bay, but most behave like diurnal migrants, turning back at Shiphead. At dawn, after thrushes have descended to the ground, a number have been seen working up along the terminal cliff margin to the Lighthouse and thence west to the forest on top of this southern ridge. High on the northern ridge above Seal Reef, hermits were found at mid-day on October 25, 1941, working both east and west through the bushes.

In leaving the Forillon thrushes not only fly west along shore but also up the coulée toward the highlands. In the same direction by daylight a few have been seen crossing the Cape Road from tree to tree.

Farther west at Rancelle Hill, and at the Griffin Cove and Fox River portages, early morning flights have been recorded on several occasions. The great majority, like the robins previously discussed, passed westward. For example, along the north bank of the Dartmouth River, 2 miles above the estuary, about 20 olive-backs were heard flying up the valley September 8, 1940. Others crossed and curved back down the south shore. On one morning a more direct crossing was made near the bridge and raised highway over the estuary from St. Marjorique to Point Navarre. From as far as 5 miles up the Dartmouth River, flights have been recorded on many mornings passing downstream to the southeastward. Studies have not yet been made beyond the frontier settlement. Here, September 6, 1949, 390 olive-backs were recorded.

From the above-mentioned bridge heavy flights of thrushes have been recorded on their way southeastward along the south shore of the estuary. Some were at least one-half mile out over the water, flankers of the main stream of migrants. Not only has this movement been recorded from several points along shore, but on one morning an unusually compact and vocal group of about 50 birds was followed by automobile as they paralleled the main highway. Their speed of flight was from 30 to 32 miles per hour over the 5-mile course to Cape O'Hara at the mouth of Gaspé basin. There most of them continued on across the mouth of the estuary to Lobster Point. A few turned along the right or north bank toward the village of Gaspé.

Special attention has been given to the York River. Both evening and early morning records firmly establish the movement of thrushes down the valley, eastward toward the bay. It is significant that the observed number of migrant thrushes increases toward the mouth of the river. Whereas 100 birds is a large count at Madeleine Fork, 25 miles west of the mouth, 300 may be heard in an equal period at Mississippi Brook, and 600 or 800 at the head of the estuary (p. 59).

The flights sweep onward down both sides of the estuary and above its waters. At least that is the impression gained by the listener from the center of Gaspé bridge; for the call notes of some birds approach from far up the center of the basin, as well as from the north shore and especially from the south over Gaspé harbor.

On October 12, 1947, a considerable number of thrushes branched off from the heavy flight down the north shore and passed northeastward through the saddle behind Gaspé village to L'Anse aux Cousins on the bay. Unfortunately poor roads prevented my getting through the portage before the birds had grounded, or passed on. Judging from experience at Gaspé basin and Cape O'Hara these thrushes would have turned eastward along the bay shore.

Projected studies along the upper waters of the Dartmouth should prove interesting, because of the peculiar course of this river (Fig. 2), which from its source in Dartmouth Lake flows north for 15 miles before turning sharply east, then southeast toward Gaspé Bay.

Far up the South Branch of the York River, near its source in the highest mountains of eastern Gaspé, known locally as the "Mine Mountains," in which lie the "Miller Claims," the hour preceding dawn on September 24, 1947, was spent listening in an early snowstorm, so cold that half an inch of ice had formed on puddles in the road. Under these conditions it was gratifying to hear 12 hermits pass down this deep and narrow valley. The direction of flight was a little east of south.

Were these the only data available, one might reasonably conclude that these birds were migrating southward over the peninsula from a more northerly region. But it is the valleys that control the flights. As will appear later, thrushes pass even northward down other rivers (p. 79). It is therefore believed that these birds were just leaving their home in the Mt. Needle region, and eventually passed out of the York Valley with the cohorts that were augmenting the flight-stream from each tributary valley. For example, 3 miles eastward on the North Branch, the last morning migrants were flying southeast as we crossed the bridge at dawn.

In 1949 two mornings were devoted to this western section of the river. The first, September 10, was warm and cloudy when I left home at 12:50 A.M., not propitious for a heavy migration. But it was clearing at 4:15

when I reached Station 1 on Caribou Brook, about a mile south of its juncture with York River at its southernmost bend. At 4:25 olive-backs in small groups began flying southward through this pass toward the St. John; at 5:02 the 32d thrush was the last heard in the air. But in a small patch of spruces left unburned in the great fire of 1941, 4 olive-backs were still interspersing their ground notes with an occasional clear flight-call.

Having recorded in 1940 evidence that, diurnally, warblers and fringillids may pass almost directly southward for 8 miles up the York River between its most northerly bend at Whitehouse and its most southerly one at the mouth of Caribou Brook, it was then surmised that this was part of a longer route from the St. Lawrence via the Madeleine River and its tributary valley west of King Mountain. Confirmatory observations were made at dawn August 31, 1949 (cool, 12°C., clear, star-light plus aurora, calm to light west wind).

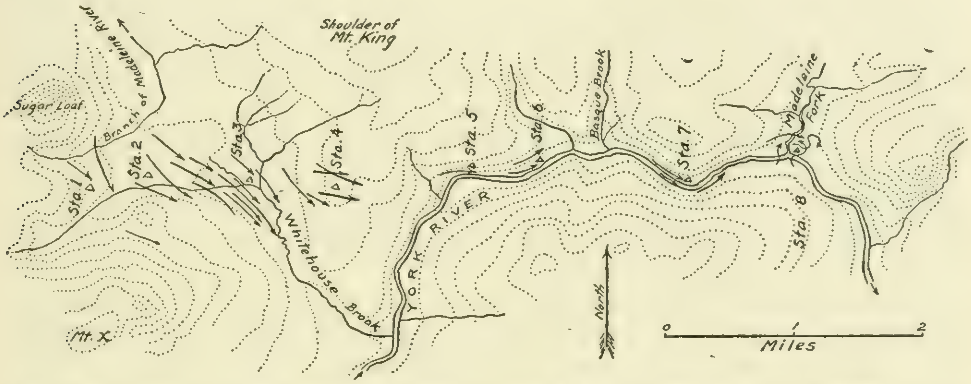


Figure 14. One morning's thrush flight in York Valley; Whitehouse to Madeleine Fork.

I reached Station 1 at 3:58 A.M. before light in the east had intensified perceptibly (Fig. 14). No calls were heard until 4:18 when the first olive-back came over from the northwest. It may have approached down the valley south of Mt. Sugarloaf, or from the north through the pass from the Madeleine Valley, and been deflected southeast by the flank of Dinner Hill. That the latter course was the true one became almost certain during the next five minutes when about 25 passed over from the north. Having thus determined the direction of flight here, I drove quickly to Station 2, where it was at once apparent that the flight as a whole was in a somewhat more easterly direction. This change was probably caused by the barrier of Mt. X on the south of the road between Stations 1 and 2, now becoming more conspicuous in the strengthening light. More than 30 thrushes passed Station 2 between 4:25 and 4:28 A.M.

At Station 3 on Whitehouse Brook the great majority of 90 thrushes heard here (4:30–4:43 A.M.) had veered south-southeastward down the brook valley toward its intersection with the York.

From Station 3 the road eastward ascends some 200 feet to the top of a hill that may be considered as a spur of King Mountain. Here at Station 4 a few thrushes were flying southeast, the majority east-southeast, but a considerable number headed directly east toward the lightest part of the sky. On another occasion at 8:00 P.M., already dark, thrushes had been passing east over this hill.

Hurrying on toward Station 5 on York River at the foot of the second hill east of Station 4, I descended through a smooth-topped trough of fog shrouding the river. Above this fog 10 or more thrushes passed eastward at 4:55 A.M. A minute spent at Station 6 yielded similar data, and again in the gorge beneath Cave Mountain, Station 7, a few olive-backs were still following the river. Here, although the fog was more dense, the light intensity was sufficiently high at 4:58 to have stopped the flight had not fog intervened, thus concealing the ground.

Station 8, at the juncture of Madeleine Fork with the York River, was reached as the fog was beginning to lift at 5:00 A.M. It was gratifying to see and hear about 20 olive-backs circling through the fog as they descended into the evergreen forest along the road near the brook. Nearly 100 were heard in this area within the next half hour. I was unfortunately just too late to hear the notes that would have determined their direction of approach. They may have been a part of the flight that I had been following down the York, or a group that had descended the Madeleine Fork tributary. This powerful stream has cut a deep and extensive valley out of the river's northern watershed.

It remained to study the deeply entrenched section of the York River south of Whitehouse in order to learn whether thrushes from the north pass upstream toward the entrance to the Caribou Brook channel to the St. John watershed, or whether some of the thrushes that follow the upper waters of the York decline the Caribou route and turn northward with the main river toward Whitehouse. It was with keen anticipation that I stationed myself at "Garlands" (Fig. 2) before dawn on September 13, 1949. Unlike the morning spent on Caribou Brook, this was favorable for a good migration movement—clear, cool (10.5°C. at 2:30 A.M.), with a light westerly wind.

The first 3 thrushes passed at 4:38 *southward upstream*, and were followed during the ensuing half hour by more than 200 others. Not one flew north. The record is reproduced here:

4:38	3
4:40	10
4:41	13
4:42	20
4:43	20
4:44	35
4:45	50
4:46–4:55	35
4:56–5:00	15
5:01–5:05	11
5:07	4 or 5 on ground, a few still in flight
5:09	an olive-back seen
5:15–5:22	25 on ground, all olive-backs, judging by calls

Referring to the thrushes heard on August 31 passing southeastward at Station 3 toward Whitehouse (p. 76), one may with some assurance conclude that many of them followed this southward route up the York.

Between the mouth of the York estuary and that of the St. John, like robins and warblers by day, multitudes of thrushes have been heard passing southeastward along the bay before dawn. Their flight-stream is broader, not restricted to the forest margin and tree-bordered shore. Thrush calls are more numerous near the latter, but are frequent above the low ridge behind Sandy Beach and in the valley of Mill Brook beyond. Stretching out from the shore for 2 miles the Sandy Beach Peninsula affords excellent listening stations from which it has been determined that migrants fly not more than half a mile out over the water. As they cross the base of the peninsula these flankers veer in closer to the shore which here bends to the right and southward into the mouth of the St. John estuary. This is further evidence of their tendency to keep above the land and their ability to distinguish its outline easily at night. As a matter of fact, like other species, thrushes have been heard in migration chiefly on nights of good visibility when night sky light strengthens the main features of the land and coastline.

To a bird passing Sandy Beach at an elevation of 150 to 200 feet above the water the broad St. John estuary would be hidden by a hill until the migrant reached Haldimand slope whence a view over lower land would be possible. It is just here that the birds veer in over the land (Fig. 10). To those flying 200 feet above the house, situated halfway up the slope, the St. John would be apparent sooner. This may explain the behavior of many birds that, instead of following the shore line, cut obliquely across the hill back of the house. At Haldimand Beach most thrushes cross the mouth of the St. John estuary toward Douglastown. Their behavior may be interpreted as indicating that by the time they have reached the flat land at Haldimand the hill behind Sandy Beach no longer cuts off their view; they see that the estuary ends 2 miles inland, and therefore swing left to pass on eastward down the shore of the bay. In other words the estuary deflects them inland only temporarily. Furthermore, they meet, at Haldimand, the migrants that, having come eastward along the north shore of the St. John estuary, are here turning southeast down the bay.

Thrush migration in this valley has been studied at night only along the estuary and for 2 miles above the highway bridge at its head. As on the Dartmouth and York, downstream flights are often heavy before dawn. To a listener near the bridge the whole valley seems full of thrushes passing down both north and south banks and the estuary as well.

Ten miles upstream the divide between this valley and that of the York is narrowed to less than 2½ miles in the vicinity of Third Lake, and has an elevation of some 400 feet, considerably less than its height farther west. Records made here have shown that hundreds of thrushes cross somewhat southeastward into the St. John Valley. They follow a line that would continue a southeasterly flowing section of the York River obliquely across the ridge into a portion of the lower St. John that flows in the same direction. These birds, it is believed, have been flying eastward along the higher part of the York's southern slope until the St. John Valley becomes visible to them over this lower portion of the divide. Those at lower elevations in the York Valley continue to its mouth.

A somewhat similar behavior is shown in the St. John Valley. The mountains to the south of it are much higher than those separating it from the York until a point 3 miles above the bridge is reached. Here the mountains curve southeastward away from the river, leaving a low ridge to continue toward Douglastown as its south bank. Opposite the bridge at the foot of the slope from the mountains it is only 125 feet high. Many thrushes flying along the south slope of the river pass through this saddle and can be detected south of Douglastown in the valley of the small river that enters the bay at Seal Cove, 3 miles farther east. Others proceed to the mouth of the estuary before turning southeastward.

Birds that follow the north bank have been heard veering east above the bay toward Douglastown. On only one morning were records obtained of thrushes turning northward up the bay at Haldimand Beach—15 birds between 4:35 and 5:07 September 10, 1947, a calm, fair morning.

Along the south shore of the bay between Douglastown and Point St. Peter the southeastward current of thrushes has been heard at many stations. Near the point a few thrushes have been traced coming obliquely in from above the water. These may have crossed the bay from the Forillon, or may have been flying parallel to the shore. Seeing only the broad expanse of the gulf beyond the point they may have then cut in over the land. From a station just south of St. Peter on the shore of the Malbay it was evident that most of the thrushes curved rather sharply back along the Malbay shore. A few turned less abruptly, passing out over the water in a direction that would bring them in over the shore farther west. Two miles beyond, at Belle Anse, on the same morning, the flight direction was parallel with the beach, and mostly above the land.

The distance across the Malbay from Point St. Peter to Percé is 6 miles, enough, as at the tip of the Forillon, to turn most thrushes back to the southwestward along the shore.

Few observations have yet been made about the Malbay. Studies at the mouth of the Malbay River should prove interesting, for the topographical conditions resemble those about the St. John. A narrow bar (Le Banc de Sable) more than 2 miles long encloses a shallow, marshy lagoon. The latter, however, extends only a mile inland, and is chiefly bare at low tide. It remains to be learned how much thrushes are here deflected from their course around the coast.

Along the south shore of the Malbay the Appalachians extend eastward to Percé (Fig. 2). At the end of the bar back of Coin de Banc a low pass carries the road through the mountains to L'Anse à Beaufils. One morning was spent on this road, with the result that over 200 thrushes were heard descending southward from the divide. A flat tire defeated my plan to return quickly to the north side before dawn, so as to determine whether birds were ascending to the pass from the Malbay.

Studies designed to determine the paths of thrushes that follow the coast around the precipitous headlands to Percé are expected to show that many do so without hesitation, but that others turn inland at Cannes des Roches into the deep, bowl-like cul-de-sac at the northwestern base of Mt. Ste. Anne. Their exit therefrom offers another interesting problem.

Returning now to the region north of Gaspé Bay (Fig. 10), it can be reported on the basis of several nights and mornings of study that many thrushes reach the bay by descending the south side of the mountain along Mosher's Brook valley that allows the highway to cross the divide from Fox River. At the summit of the pass they have, with few exceptions, been heard flying southward as though to descend the valley just mentioned. It is of especial interest that into this partially cleared saddle the majority of the birds were traced out of the mountains on the west; still there was a considerable contingent that ascended into it from the north along Fox River. A small number from the mountains west of the pass crossed the road in a direction that would have carried them eastward along the north side of the range.

From several stations on the north- and northeasterly flowing Fox River thrushes have been heard flying upstream toward the pass. More striking was movement northeastward down the valley on other mornings. These probably were birds that originated in the mountains along the divide and were on their way out to the north shore. Those heard ascending the valley may have been residents from below that were on their way south toward the pass, or again they may have branched off from the St. Lawrence flightline that crosses the mouth of Fox River.

From Fox River east to Cap des Rosiers the course of migrant thrushes has been followed to the Forillon. To the westward a few evening observations between Fox River and Grand Étang confirm the eastward flight along the north shore of the peninsula. No early morning records have yet been made west of Fox River except in the region of Ste. Anne des Monts. There, movement was strongly westward, probably out of the Ste. Anne Valley, September 25, 1949.

STE. ANNE DES MONTS REGION

Ste. Anne des Monts village is situated at the mouth of the Ste. Anne River, 110 miles west of Cap des Rosiers, on the southwestward sweep of the St. Lawrence coast of the Gaspé Peninsula. A good road leads southward 25 miles to the base of Mt. Albert in the Parc de la Gaspésie (Fig. 2). This park protects the highest part of the Shickshock Mountains, including Mt. Albert, 3700 feet, and the Tabletop Mountains, some of whose peaks exceed 4000 feet in height. Mt. Jacques Cartier (Botanist's Dome), 4160 feet, is the highest. From its source in Lake Ste. Anne, the river flows northward for 10 miles to its juncture with the East Branch, then curves sharply beyond the base of Mt. Albert to pursue a westward course 15 miles along the base of the Shickshocks' northern escarpment, finally resuming its northward course for 11 miles through the foothills to the St. Lawrence.

At 3:50 A.M., September 18, 1947, Monsieur Peltier, gate-keeper at the border, was so kind as to allow entrance to the park at this early hour. By 4:30 I was stationed at X, Figure 2, on the north bank of the river. At 4:45 the first 2 thrushes flew westward down the valley. Others followed; by 4:57, at a station 4 miles farther up the valley, 25 could be heard in the air at once. Most of these also passed northwest downstream, but a few turned almost directly north up a tributary as though to shorten the distance to the coast. Farther up the river, from 5:05 to 5:15, about 50 thrushes flew northward past the foot of Mt. Albert on their way down the valley. At 5:24 the first ground calls of olive-backs and hermits were heard. Some 30 of them had descended within 200 feet of me by 5:30 A.M.

In late September 1948, five days were devoted to a reconnaissance of the region about Mt. Albert. Although the first four mornings were rainy or cloudy, important records were obtained.

Opposite Mt. Albert the main river is joined by the East Branch, a stream nearly as large, that receives tributaries from the western and northern parts of Tabletop as well as from the lower plateau that extends toward the St. Lawrence (Figs. 2, 15). On September 23, 26 olive-backs and hermits descended the branch, and 44 the main river. These all continued down the Ste. Anne. Notable was a group of 6 olive-backs that flew a reverse course up the branch. The next morning proved even more interesting; at least 193 thrushes passed down the valley, and about 100 southeastward up the Ste. Anne past the mouth of Moose gully. It is not known what occurred when the birds reached the mouth of the branch 3 miles up the river; whether some ascended it, or whether all continued up the Ste. Anne through the comparatively low pass (1505 feet elev.) south of Lake Ste. Anne to the headwaters of the Little Cascapedia (p. 7). As explained in the introduction and confirmed by observations in 1950 and 1951 (p. 125), this is an ideal route southward across the peninsula. The branch, on the other hand, would lead birds either back to the northeast upon the plateau, or southeastward along tributaries to the base of Tabletop Mountain.

On one other morning of weak migration a single thrush flew up the Ste. Anne toward the lake.

As mentioned above (p. 7), a few miles west of Mt. Albert another north-south avenue through the 2500-foot plateau is presented by the narrow pass in which lie Lakes Thibault and Coté, headwaters respectively of the Salmon Branch of the Cascapedia River and of Coté Brook, a northerly flowing tributary of the Ste. Anne. Between these two lakes the pass crosses the sharp divide 1915 feet above sea-level. On the south, the Cascapedia Valley slopes gently, but Coté Brook plunges more than 1000 feet in a mile and a half down the Shickshocks' northern escarpment. Approached over the intervening foothills from the St. Lawrence River on the north, through St. Octave de L'Avenir, this escarpment is an impressive barrier to low-

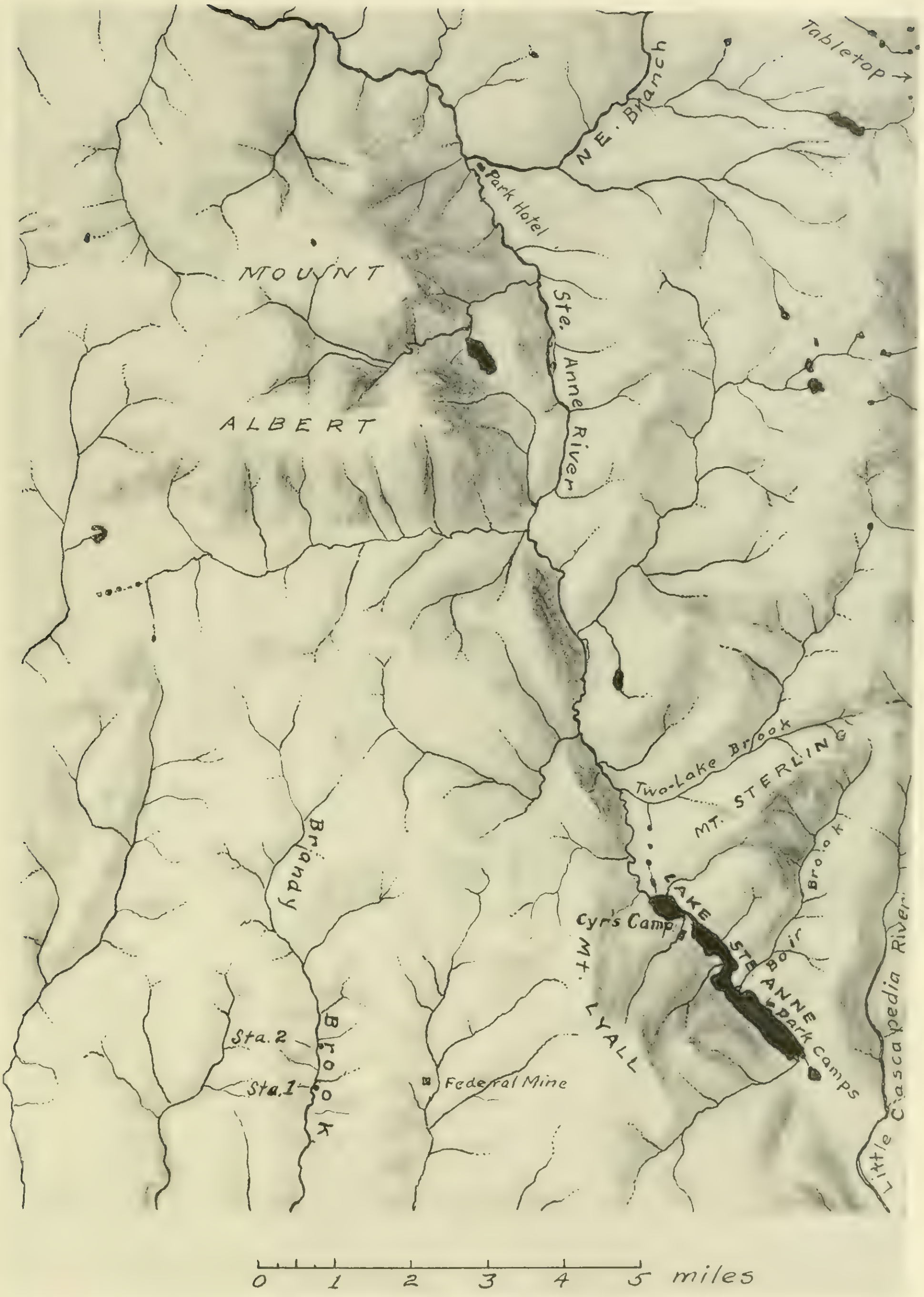

Tabletop →
N.E. Branch
Park Hotel
MOUNT
ALBERT
Ste. Anne River
Two-Lake Brook
MT. STERLING
Brook
Boir
LAKE STE. ANNE
Cyr's Camp
Park Camps
MT. LYALL
Little Cascapedia River
Brandy Brook
Sta. 2
Sta. 1
Federal Mine
0
1
2
3
4
5 miles

Figure 15. Relief map of Lake Ste. Anne—Mt. Albert region, including upper waters of Brandy Brook. Based on Alcock's (1926) contour map.

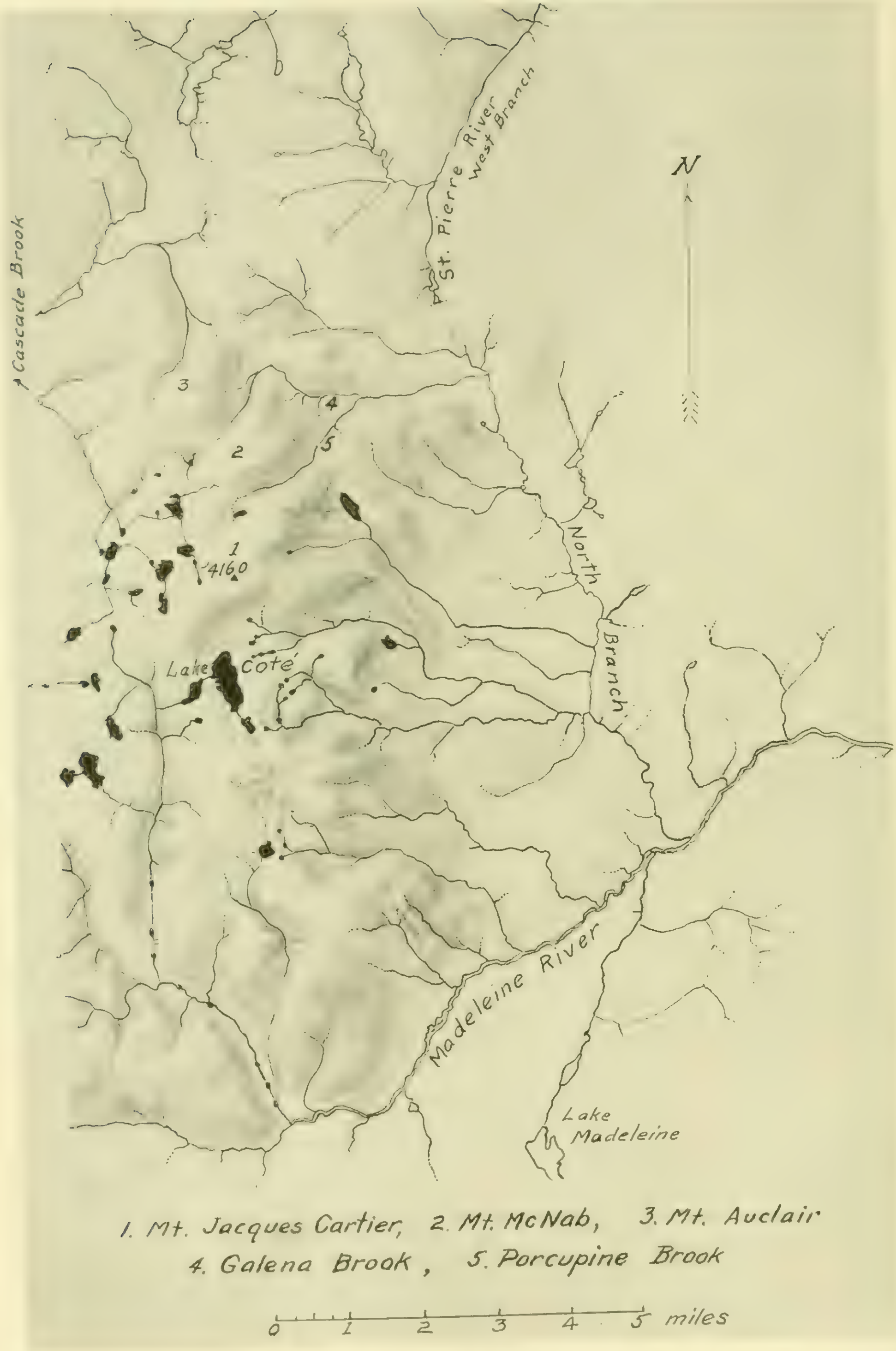

Cascade Brook
St. Pierre River
West Branch
N
3
4
2
5
1
4160
Lake Cote
North Branch
Madeleine River
Lake Madeleine
1. Mt. Jacques Cartier, 2. Mt. McNab, 3. Mt. Auclair
4. Galena Brook, 5. Porcupine Brook
0 1 2 3 4 5 miles

Figure 16. Relief map of the Tabletop Mountains. Based on contour map by Jones (1933).

flying thrushes. On the morning of September 25, 1949, more than 200 hermits passed westward over my station at the base of the mountain front 1½ miles west of Coté Brook's debouchment into the lowlands. Had they descended the Ste. Anne Valley, as I have recorded on other occasions, or had they followed Coté Brook out of the plateau? If, as another possibility, one were to regard them as a group that had accumulated along the northern coast of Gaspé, arriving either from the highlands east of Ste. Anne des Monts or from across the St. Lawrence (cf. Appendix p. 194, Fig. 29, relative to Sept. 25, 1949), their failure to enter the pass just described can perhaps be explained by the fact that a low-lying cloud blanket hid all but the mouth of the gorge, as well as the entire plateau above. Birds seeking a southward avenue under these conditions would be expected to continue southwestward around the base of Mt. Logan.

At this time visibility southeastward up the Ste. Anne appeared sufficient to have attracted westbound migrants skirting the northern flank of the Shickshocks. This avenue supposedly would appeal more strongly to thrushes from north of the St. Lawrence than to birds that had recently descended some valley from the Gaspé mountains.

The topography about Ste. Anne des Monts strongly suggests that these 200 thrushes had flown down the Ste. Anne River and would not be enticed back into the highlands. That westward movements occur here is further shown by observations at Cap Chat of warblers and sparrows following the shore.

LAKE STE. ANNE REGION

Observations were made at Lake Ste. Anne during the periods of September 20–22, 1950 and September 10–18, 1951. In order to avoid repetition and inconvenience the description of this region and the results obtained are presented with a discussion of them on pages 124–131.

TABLETOP REGION

In order to determine whether migrant thrushes can be detected above the highest Gaspé mountains, I was permitted to make observations on the mornings of September 7 and 8, 1950, in the Tabletop Mountains of Gaspé National Park (Fig. 16).

In the dawn twilight of the 8th limited but striking affirmative evidence was obtained at the summit of Mt. Jacques Cartier, long known as Botanist's Dome. Its elevation above sea level is 4160 feet (Jones, 1933), greatest in southeastern Canada. It rises, with 21 other peaks exceeding 3500 feet, from the Tabletop plateau which has an average height of about 3000 feet, and extends some 10 miles from its northern to its southern crest, and 4½ miles from east to west. Tabletop marks the eastern end of the Shickshock Mountains.

Mt. Jacques Cartier is not strictly a dome, but includes two rounded prominences connected by a shallow saddle (Fig. 17). The longer axis of the mountain lies in the direction north-northeast to south-southwest. That

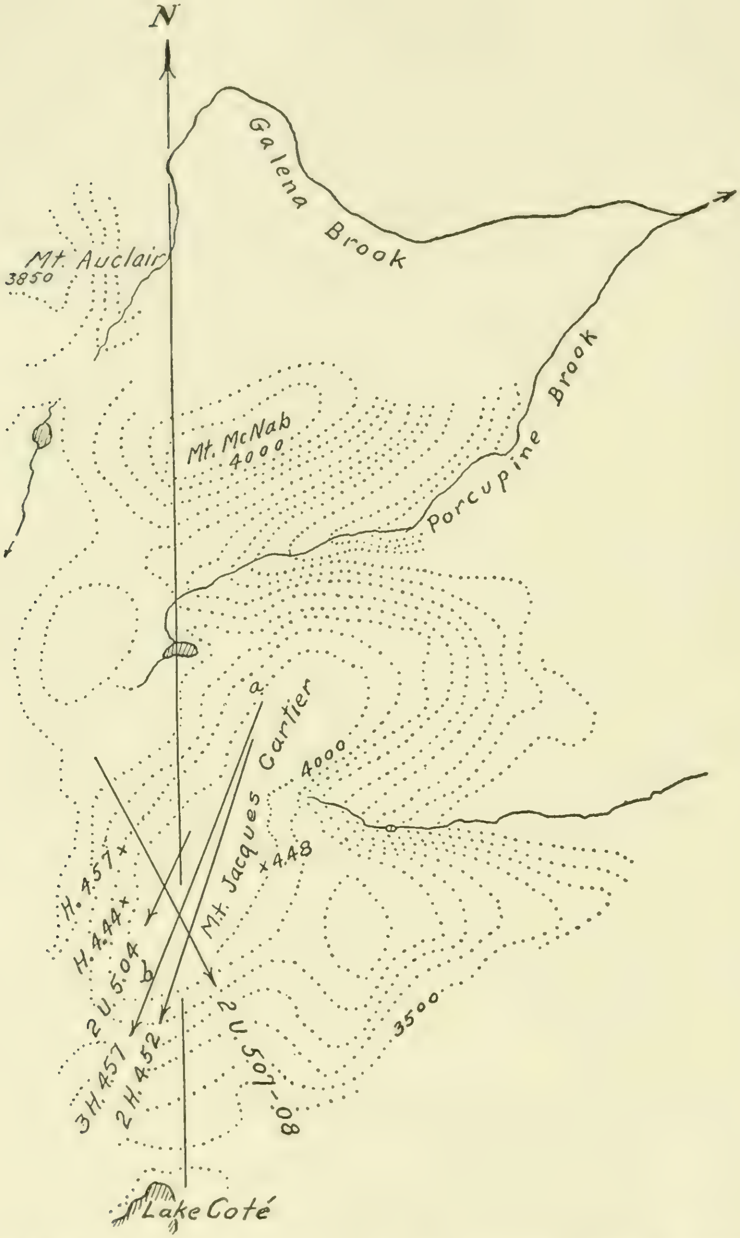

N
Galena Brook
Mt. Auclair
3850
Mt. McNab
4000
Porcupine Brook
a
Mt. Jacques Cartier
4000
×448
H. 457×
H. 444×
2 U. 504
b
2 U. 507-08
3 H. 457
2 H. 452
3500
Lake Coté

Figure 17. Paths of migrating thrushes over Mt. Jacques Cartier, highest elevation of Tabletop and the Shickshocks. H = *Hylocichla;* U = olive-back.
]

of Mt. McNab on the north, 100 feet lower, has a trend nearly east-northeast to west-southwest. Between the two, Porcupine Brook, a tributary of the Madeleine River's north branch, flows northeastward down a steep valley from a small lake at an elevation of 3650 feet. Into this valley, from the summit of Mt. Jacques Cartier, the slope descends 200 feet in the first mile, then steeply another 1000 feet in half a mile, and 850 feet more in the next mile and a half to the juncture with Galena (Michaud) Brook. Thence the descent is less steep. This valley may have served the thrushes as an approach to Jacques Cartier from the northeast, as it does for man along a stony road.

A word is in order concerning the meteorological conditions under which these Tabletop studies were made. A series of unseasonably early frosts in the lowlands ended with the cloudless morning of September 6. As I left Sandy Beach for St. Pierre, the temperature had risen to 9°C. at 8:30 A.M., accompanying the approach of a cloud screen, and remained so throughout the day. By sunset on Mt. Jacques Cartier the prevailing westerly wind had freshened to 30 m.p.h. west-northwest. At 8:00 P.M. it had swung back to west-southwest.

We reached the top of Mt. Jacques Cartier in midafternoon at the end of a 25-mile rocky ascent by jeep-mobile. The only bird life seen en route was an occasional covey of grouse and a few juncos and myrtle warblers. While studying the terrain and plants near the summit a pair of pipits (*Anthus spinoletta rubescens*) flew past, and 3 northern horned larks (*Eremophila a. alpestris*) ate crumbs and suet thrown in the lee of the Fire Guardian's Camp.

The larks almost certainly were summer residents of the summit of Mt. Jacques Cartier, for the Guardian declared that he had been feeding them all summer. Although I saw no pipits near the camp, they also breed on these highlands, the only known territorial locality of either species south of the St. Lawrence (Townsend, 1923). As a matter of fact the 2 pipits observed were flying in the direction of the camp. However, this course was southward, so that they may conceivably have been diurnal migrants.

At 4:00 A.M., September 7, the temperature still registered 9°C., but the force of the west wind had increased to 40 m.p.h.—a gale. Clouds now enveloped Tabletop, driving swiftly eastward. At rare intervals a partial instantaneous disclosure of the young moon occurred through small areas less dense in the scudding blanket. The barometer had fallen slightly during the night but had risen 0.50 inches by 10:15. Thence it fell 0.54 inches at 10:45, accompanied by the onset of rain at 10:40.

At 12:50 the wind's velocity began to abate (WNW–35), while the sky over the coast had become overcast. By 4:30 P.M. the cloud blanket had risen slightly from the summit. Although considerable haze reduced definition as the setting sun dropped below the cloud layer, the view in all directions was now unobstructed.

The only birds recorded on this day were horned larks about the camp.

The wind velocity had decreased almost to zero by midnight. At 4:00

o'clock next morning it was northwest 15 m.p.h., temperature 10°C., the sky clear, and haze less troublesome. The moon and a weak Aurora added luminosity.

By 4:35 the light intensity had increased to 0.0001 f.c., my pencil casting a faint shadow upon the field book. The first thrush call was heard at 4:44, light intensity 0.0015 f.c. The last 2 olive-backs passed at 5:08, when field notes could be read easily. Emerging beyond the flat mountain horizon, the sun appeared about 6:05.

Visibility now permitted a view of the low mountains 80 miles distant behind the northern shore of the St. Lawrence (Fig. 1). They disappeared in mirage near the Mingan Islands beyond Anticosti Island. One could easily conceive oneself in the place of a thrush north of the wide lower waters of the river, and imagine the bird's view of the much higher Shickshocks. Nevertheless these highlands in the sun's early rays, especially through the light haze, would lose contrast against the sky. Before dawn, when migrants must have left the north shore were they to undertake such a crossing and reach Jacques Cartier at the hour recorded, the Shickshocks would have been nearly or quite invisible.

On the western horizon beyond Mt. Albert other high peaks of the Shickshocks were plainly seen—Mt. Logan being the most conspicuous. Sixty miles to the south the Bay of Chaleur just escaped detection behind the mountains along its north shore.

After dawn the wind diminished to northwest 5 m.p.h. at 9:30 A.M. and remained light throughout the day.

At 9:00 a descent of Mt. Jacques Cartier's dome was made in the hope that evidence of thrushes might be discovered below timber line at 3700 feet. Only a pipit, a junco (*Junco hiemalis*), a myrtle warbler (*Dendroica coronata*), a tree sparrow (*Spizella arborea*), and 2 robins (*Turdus migratorius*) were noted during a 2-hour circuit. Whether these robins were migrants or residents is unknown, but an abandoned nest was found in a small spruce in boggy ground at the foot of the dome.

It was surmised above that Porcupine Brook valley is sometimes ascended by birds, as well as man. At any rate, the paths of 7 to 9 of the 12 thrushes heard passing over the summit at dawn suggested that the birds had ascended this valley. This was especially emphasized by a group of 3 that were audible for the minute 4:57–4:58 (*a* to *b* in Fig. 26). At *a* they were below my station and very close to the treeless surface. In order to cross the top they rose at least 75 feet, some 20 feet above my head. Two others following a similar course, passed at 4:52 at the same level as my station, or slightly below, and 50 yards to the eastward. Twelve minutes later (5:04) another pair, coursing along the western slope, sounded distinctly lower.

The evidence provided by a pair, believed to have been olive-backed thrushes, that were recorded by their series of calls (5:07–5:08), may be interpreted in two ways. Their course was south-southeast, again rising to clear the summit. Therefore it is assumed that they either, 1) ascended Porcupine Brook but proceeded farther southwest above Tabletop before swinging up over Jacques Cartier, or, 2) they ascended one of the three more northerly and westerly valleys through which the plateau is drained. One of these (a), contains Galena (Michaud) Brook between Mt. McNab and Mt. Auclair; the next (b), the southeasternmost tributary of the northeast branch of the Ste. Anne River; the third (c), Cascade Brook that joins the northeast branch west of Little Ste. Anne Lake.

There remains the possibility that these thrushes heard migrating over the summit of Mt. Jacques Cartier, had flown only a short distance, say from the timber a mile distant, and 700 or 800 feet below. But this seems dubious for the reason that breeding birds from this altitude would probably have been *Hylocichla minima bicknelli.* These birds certainly were neither of this, nor the larger race, *H. m. minima.*

Again, they may have started their flight from some distant point along the northeast branch or the Ste. Anne River itself. Indeed, one may be justified in regarding these birds as answering partially the question posed by 6 thrushes recorded September 21, 1948, that turned up the East Branch from its confluence with the Ste. Anne (p. 80). From this valley they may have strayed to the summit, directed upward by air currents rising through such glacial cirques as that occupied by Lac aux Americains, or through the valley of Cascade Brook, previously identified.

CASCAPEDIA RIVER AND SOUTH SHORE REGION

Spectacular confirmation of the expected *southward migration* along rivers flowing into Chaleur Bay was obtained on September 19 and 20, 1949, during an 8-day reconnaissance circuit of the peninsula. Although, with the exception of the 17th, this period was cloudy with considerable rain (Fig. 29), a strong movement down the Cascapedia River was recorded at dawn on the 19th near Lazy Bogan and Parson's Pool at the foot of Mt. Noble (Fig. 2). Between 4:53 and 5:50, during the intermittent rain, more than 850 thrushes, accompanied by a few horned larks, passed Station 1. Of these, about 125 are believed to have been gray-cheeked or Bicknell's thrushes, or a mixture of both subspecies; the majority were hermits. Several descended to the vegetation along the banks of the river at the usual intensity of light, 0.01 to 0.02 f.c. Others were found 2 miles farther downstream an hour later. Since Parson's Pool is 35 miles from the river's mouth, none of this horde of thrushes could have reached the bay before the normal time of flight cessation.

At 8:05 A.M. a flock of 100± horned larks flew down the river. This species nests above timber line on Mt. Albert and the Tabletop Mountains; probably also on Mt. Logan and other elevations in the western Shickshocks. Whether these particular birds had just left these breeding grounds, or more northern territory, is unknown.

In the evening, still cloudy and very dark, a few hermits flew southwestward past the camp on Berry Mountain Brook. These could not have flown far; they must have begun their flight from some locality south of the main divide.

The next morning was still cloudy and warm. At the same moment as at Lazy Bogan, 4:53 A.M., the first thrushes began passing Station 1 on Brandy Brook west of the Federal Mine (Fig. 16). Swollen by the rains this brook was now a mountain torrent, roaring so loudly that the migrants' pipes were hardly audible. A swift run up the road to Station 2 permitted the making of a successful count. Beginning with a hermit's call at 5:02, the numbers gradually increased to 65 birds per minute at 5:30 then dropped quickly, the last 10 passing at 5:34. Thereafter some 15 thrushes, chiefly gray-cheeks, were audible till 6:17 in the partially cut forest along the road. The total was 550, of which about 60 were identified as gray-cheeks.

Even the earliest of these migrants could not have reached the bay 45 miles to the south before dawn would have brought them to the ground. A speed even of 30 miles per hour would have enabled them to fly only 21 miles to Y on the map (Fig. 2).

The evening of this same day, September 20, was spent at Maria, 4 miles west of the Cascapedia's mouth. Here the coast of Chaleur Bay trends southwest to Carleton, and is backed by mountains a mile or two distant across low farm land, continuing the steep slope of the Cascapedia's west bank. Southwestward along this shore and above the fields 450 thrushes passed during the period, 7:35 to 9:00 P.M. The flight had nearly ended, as far as call notes proclaimed, when, as previously stated, I left at 9:00 P.M. for the eastern shore of Cascapedia Bay. Here only a few migrants were heard so late in the evening. Although inquiry among the fishermen disclosed no evidence that a horde of piping birds had just passed their homes, the possibility remains that such a coastwise flight of birds from the east occurred there.

It is believed, however, that those thrushes passing Maria had poured out of the Cascapedia Valley and turned westward along the north shore of the bay. Two lines of evidence support this conclusion. First, we have learned that large numbers of thrushes had descended the Cascapedia and its northern tributary during the preceding 38 hours, and that all those recorded at dawn of this day on Brandy Brook must have descended to feed somewhere along the brook or river. Doubtless, as on the 19th, others at the same time descended the main stream and other tributaries. Some of these should have resumed their flight on this evening, perhaps as early as 7:00 P.M.

Calculations based on a 30-mile per hour flight speed lead to interesting possibilities. One may assume that the earliest migrants heard on Brandy Brook (4:53 A.M.) came to earth at about 5:30–5:35 as dawn was breaking. This half hour would have enabled them to reach a point below Porc-á-pic Rapids. Therefore, during the day at least 550 thrushes were resting and feeding between there and Station 2 on Brandy Brook. Basing an estimate on the following evening's observations at Maria, and assuming that thrushes would not take flight before 7:00 P.M., the latest arrivals would have had at least two hours of twilight and darkness, 7:00 to 9:00 P.M., in which to travel. Assuming that they had come down the Cascapedia, they may have begun their flight as far north as the line - - - - -, Figure 2. This includes the entire Cascapedia watershed.

The birds reaching Maria during the height of activity (7:50–8:30 P.M.) may have started from the lower part of the valley at any time between 7:45 and 8:25. The most distant possible point of origin would have been about 25 miles upstream near Joshua Brook. This falls short of the southern limit attainable at dawn by migrants that passed Station 2 at the beginning of this morning's vocal period (5:02 A.M.). Among the later ones heard at Maria may have been some of the thrushes that passed down Brandy Brook 16 hours earlier. This evening flight differed from those of the two previous mornings in the proportion of birds, 17:530 (3%), uttering sharp *"cheer"* calls and identified as gray-cheeks. The numbers on September 19, A.M., were 125:725 (15%) and September 20, A.M., 60:450 (12%). These figures, however, may not represent the true proportion of gray-cheeks to hermits and olive-backs; for in the evening more of the gray-cheeks may have uttered piping notes indistinguishable from those of the other two species, and fewer of the harsh falling notes.

The second fact supporting the probability that the thrushes heard at Maria had descended the Cascapedia Valley is their unusually large number; no such abundance of evening migrants within so short a period (1½ hours) has been recorded elsewhere in Gaspé, or about New Haven. The conclusion that they represented a part of the large flights recorded on the two preceding mornings seems reasonable.

Supplementary evidence may be found in the following observation. Only 8 thrushes were recorded passing Maria next morning (partly cloudy), strongly indicating that the previous evening's mass flight marked an end of a period of heavy migration. As to the beginning of this period no data are available except that no thrushes passed the camp on Berry Mountain Brook during the evening of September 18. The morning of this day had proved particularly barren at the mouth of the Bonaventure River 23 miles east of the Cascapedia, admittedly not adducible as evidence that the movement past Maria had emerged from the river last named. Nevertheless it fits unobtrusively into that picture.

Point Bonaventure is not only near the mouth of an important river that should lead migrants to the coast but stands at the southernmost bulge of the Gaspé Peninsula. It is assumed that many migrants from the northeastern and eastern parts of Gaspé pass this point on their journey around Chaleur Bay. This is based on their observed behavior about the Bay of Gaspé and the Malbay north of Percé; also upon the general trend of the shore line. (*See also* p. 88 for migration behind the coast.)

It is to be noted that the coast leads northwesterly from Point Bonaventure. The first part is so close to north one wonders whether migrants descending the Bonaventure River to its mouth may not continue to the

Point rather than turn northwestward. The morning of September 18 was devoted to the region about the mouth of the Bonaventure. A single olive-back or hermit's brief *pwit* was heard twice after dawn in the brush on the east bank. The only evidence of migratory activity was the westward passage of a few robins and myrtle warblers. Further study along this coast is intended.

Similarly at the mouth of the Cascapedia the map suggests that birds leaving this valley, with equal prospect of making southward progress, may turn either right toward the head of the bay or left toward Black Cape and Point Bonaventure. As stated above one attempt was made on the evening of September 20 to ascertain the direction and strength of flight just east of the Cascapedia's mouth. The negative result is rendered inconclusive by the fact that the bulk of migrants had already passed Maria during the preceding hour.

Even more disconcerting was the small number of migrants (8) at Maria on the morning of September 21, for strong flights usually occur at dawn. Did the east shore of the bay attract them on this morning, or was there no movement in the Cascapedia region?

Experience in northeastern Gaspé having shown migrants at dawn attracted toward the brightest part of the horizon, the same reaction may have occurred at the mouth of the Cascapedia, directing the thrushes southeastward toward Black Cape.

Migration down the Little Cascapedia was inferred from observations made in the slope west of it 3 miles from its mouth. Here only scattered remnants of forest remain on the farmlands that extend over the ridge to the Grand Cascapedia. Partial confirmation was obtained on September 8 and 9, 1951, at 4:38 to 5:09 A.M., when more than 100 olive-backed thrushes rose obliquely up the slope from the vicinity of the river and passed at low elevation over the flat-topped divide. They proceeded beyond audible range in a direction that would have brought them to the Chaleur Bay coast near the mouth of the Grand Cascapedia. On both mornings some of the last birds to arrive at dawn as usual descended to rest and feed.

Another aspect of migration in southeastern Gaspé needs study. Contour and relief maps reveal the comparatively low elevation of the region many miles behind the coast. There may prove to be a southwestward trend of migrants over this area; birds from the various valleys may, as from the York to the St. John, surmount low divides in an attempt to shorten their route around the bay. This movement would be difficult to detect, for the birds would not be concentrated by such an escarpment as exists between Maria and Carleton, and west of Ste. Anne des Monts on the north shore.

It is expected that migration through the valleys of the Grand, Pabos, Bonaventure, and smaller rivers will likewise prove to be radial from the mountains toward the Gulf of St. Lawrence and the Bay of Chaleur.

The observed lines of bird migration on the Gaspé Peninsula thus far set down may be summarized as follows:

1. A general coastwise migration to the southeast is apparent along the north shore, on the Forillon, about Gaspé Bay, the Malbay, and Chaleur Bay. It is most clearly shown at night by the call notes of thrushes. Diurnal migrants demonstrate minor irregularities due to their tendency to adhere rather strictly to the land and shore lines. It becomes even riparian along estuaries and streams. This is probably an expression of their need to search for food.
2. There is strong nocturnal movement of thrushes down valleys. On the St. John, York, and Dartmouth rivers the direction is east and southeastward, and on the Cascapedia southward; on Fox River it is northeastward; on the Ste. Anne north and northwestward. Reverse (southward) movements have been detected at early dawn on the two latter streams alone.
3. While diurnal movements are as a rule also down the valleys, a westward drift along the St. John, York, and Dartmouth rivers is at times unmistakable.

DISCUSSION

RADIAL MIGRATION AND ITS ORIGIN

Radially, then, from the interior of the Gaspé Peninsula birds reach the coasts by descending many valleys. Although not yet observed, others from northern Quebec and Anticosti doubtless cross the broad lower part of the St. Lawrence River to land upon Gaspé's north shore. Having attained the coasts all these birds show that aversion to the water attributed to European migrants by Van Dobben (1944) and Vleugel (1943). With few exceptions they refuse to cross even small bays; large bays and the gulf are avoided, as by the birds recorded by L. Tinbergen (1941) that cross Holland in a broad westward advancing front that is turned southward by the east shore of the Zuyder Zee and the northwest coast of Holland. Gaspé migrants have been recorded following the coast through many localities, Cap Chat, Fame Point, Fox River, Griffin Cove, Cap des Rosiers, the Forillon, Gaspé Bay, Malbay, and Chaleur Bay. Proceeding thus on a narrow front these birds, as proposed by Schüz (1950), exhibit an "ecologic compulsion" to follow a well marked course.

That migration occurs simultaneously down valleys trending in various directions has been observed at the divide between the northward-flowing Fox River and the southward-flowing Mosher's Brook (Fig. 10), also at a divide between tributaries of the St. John and Grand rivers (p. 157, and Fig. 23). Through the cooperation of other observers it was established that, while I was recording northward movements down the Ste. Anne River, other thrushes were descending the York eastward. Records made at Lake Ste. Anne indicate that still others departed southward along the Little Cascapedia. Similar evidence of movement from Whitehouse both southward up the York River and eastward downstream has been obtained (p. 75). This last instance is important as an illustration of choice made near the bend in the river at Whitehouse, whereby two groups diverged at a 100° angle.

This remarkable radial character of migration from the highlands of Gaspé may on the one hand, be regarded as wholly due to the preponderant tendency of birds, especially thrushes, to descend valleys. On the other hand, tradition being important, one is tempted to trace the origin and development of this radial pattern. Thrushes, for example, would not have entered Gaspé until the Laurentian ice sheet and the local ice caps centered in the higher Shickshocks had disappeared some 25,000 years ago in the Mankatan substage of the Wisconsin (Flint, 1947), allowing the evergreen forests to return. They may first have spread northward up the Matapedia Valley and across the 700-foot divide so as to continue eastward over the low northern border of Gaspé as far as Ste. Anne des Monts, where high land extends to the water's edge on the St. Lawrence shore. Birds doubtless followed this path and advanced up the rivers along with or after the forest fronts.

High bluffs bordering the western end of Chaleur Bay, even higher at the last uplift after the disappearance of the Pleistocene glaciers (Alcock, 1926), may have delayed, but not long blocked, the conifers from pushing into the low southeastern part of the peninsula. Behind the mountain barriers that reach the gulf at Percé and east of Ste. Anne des Monts, the Gaspé Bay and northeastern coastal regions probably were the last to be forested, but hardly late enough to have affected the advent of thrushes.

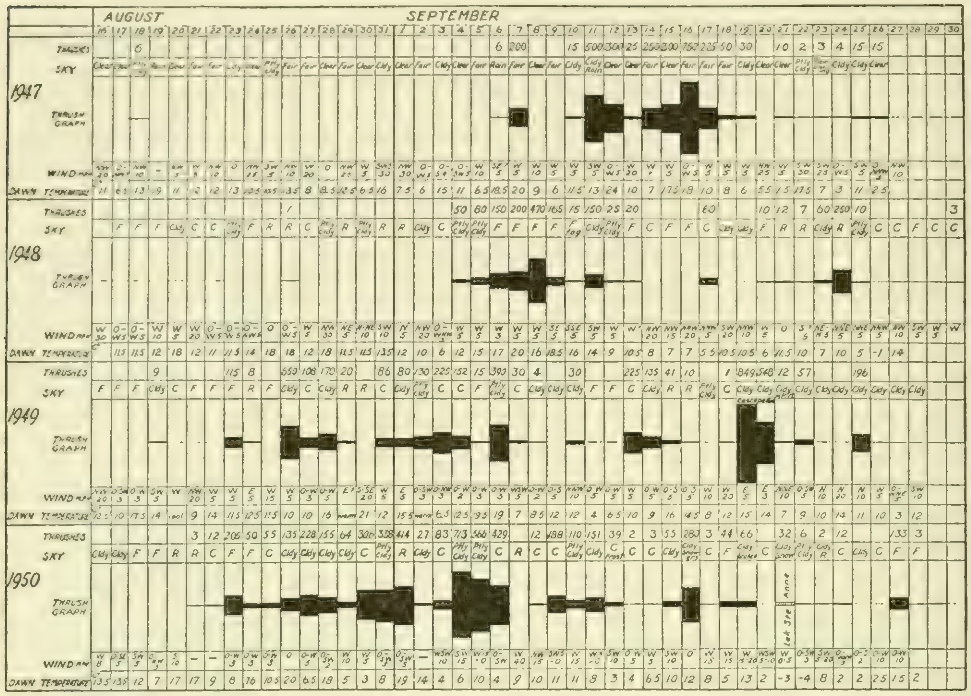
There is fair evidence that *Hylocichla* was present, at least in western North America, in the late Pleistocene. Bones of a thrush, possibly extinct, have been found at Carpinteria, California (A. H. Miller, 1932). With the return of endurable temperature and forests to provide food and cover, the birds probably were not long, geologically speaking, in advancing into the lower lands of Gaspé. Thence they followed the forests, spreading through the valleys and up the mountain slopes.

Whatever the thrushes were, they doubtless found plenty of food. Plant succession probably took much the same course on those early rock and glacial drift surfaces that it now does wherever the vegetation has been removed. According to Nichols (1918), lichens and lithophytic mosses, ferns (*Pteris aquilina*, *Polypodium vulgare*), and such herbaceous seed plants as hairgrass (*Deschampsia flexuosa*), Junegrass (*Danthonia spicata*), and bunchberry (*Cornus canadensis*), are among the earliest to appear. Then follow more important shrubby plants, the ericaceous berry-bearing forms, blueberries (*Vaccinium*), bound by more luxuriant lichens into a type of heath. Next come shrubs, junipers, service berries (*Amelanchier*), crow-berry (*Empetrum nigrum*), willows, and alders. All except the two last named provide fruits for thrushes today. Trees to provide cover can now be expected—pine, balsam fir, spruces, white birch, mountain ash (*Sorbus*) and pin cherry (*Prunus pennsylvanica*), both important fruit trees, and red maple (*Acer rubrum*).

Therefore, as soon as the necessary forest cover became available, thrushes would have found, at least around its margins, an ample supply of fruits. Present also would have been the required insects, and doubtless snails as well.

Owing to the predilection of thrushes for fruits, one may well imagine that they awaited the succession and entry of such trees as the fire cherry and mountain ash. On the other hand, blueberries and crow-berries may have preceded and accompanied development of the pure spruce and balsam forests. Under these conditions thrushes might have entered Gaspé earlier.

Reasoning thus, the earliest ancestors among our birds doubtless migrated along the coasts. By degrees their successors pushed their frontiers up-valley in the spring and retreated to the coasts each autumn. Not until later, when forests attained the hilltops, would the crossing of divides and the use of passes have occurred.



	AUGUST 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1947 Thrushes			6													
1947 Sky	Clear	Clear	Ptly Cldy	Rain	Clear	Fair	Fair	Cldy	Clear	Ptly Cldy	Fair	Fair	Clear	Fair	Clear	Cldy
1947 Thrush graph																
1947 Wind mph	NW 20	O-NW	NW 10	–	SW 5	W 8	NW 10	O	NW 15	SW 5	NW 10	W 20	O	NW 25	W 5	SWS 30
1947 Dawn temperature	11	65	13	9	11	2	12	13	135	105	135	8	85	125	65	16
1948 Thrushes											1					
1948 Sky		F	F	F	Cldy	C	C	Ptly Cldy	F	R	R	C	Ptly Cldy	R	Ptly Cldy	R
1948 Thrush graph																
1948 Wind mph	W 30	O-WS	O-WS	W 10	W 5	W 20	O-WS	O-WS	O-NWS	O	O-WS	W 5	NW 30	NE 5	N-NE 10	SW 10
1948 Dawn temperature °C		115	11.5	12	18	12	11	115	14	18	18	12	18	11.5	11.5	135
1949 Thrushes				9				115	8		650	108	170	20		86
1949 Sky	F	F	F	Cldy	C	F	F	F	R	F	Cldy	C	Cldy	R	R	C
1949 Thrush graph																
1949 Wind mph	NW 20	O-SW 3	O-W 5	SW 5	W	NW 20	W 5	W 5	E 5	W 15	W 5	O-W 3	O-W 5	E	S-SE 20	W 5
1949 Dawn temperature	125	10	175	14	cool	9	14	115	125	115	10	10	16	warm	21	12
1950 Thrushes						3	12	206	50	55	135	228	155	64	300	338
1950 Sky	Cldy	Cldy	F	F	R	R	C	F	F	C	Cldy	Cldy	Cldy	Cldy	C	Ptly Cldy
1950 Thrush graph																
1950 Wind mph	W 8	O-SE 5	SW 5	O-NW 3	S 10	–	–	O-W 3	O-W 3	O-W 3	O	O-W 5	O-SW 2	W 10	W 5	O-SW 5
1950 Dawn temperature	135	135	12	7	17	17	9	8	16	105	20	65	18	5	3	8

	SEPTEMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1947 Thrushes						6	200			15	500	300	25	250	300	750	225	50	30		10	2	3	4	15	15				
1947 Sky	Clear	Fair	Cldy	Clear	Fair	Rain	Fair	Clear	Fair	Cldy	Cldy Rain	Clear	Clear	Fair	Clear	Fair	Fair	Fair	Cldy	Clear	Clear	Ptly Cldy	[illegible]	Cldy	Cldy	Clear				
1947 Thrush graph																														
1947 Wind mph	NW 30	O-WS	O-S4	O-SWS	W 10	SE 5	W 5	W 10	W 5	W 5	SW 5	O-WS	W 20	W [illegible]	W 5	O-WS	W 5	W 5	W 5	NW 25	W 5	SW 30	SW 25	O-WS	SW 5	O-NW 5	NW 10			
1947 Dawn temperature	75	6	15	11	65	185	20	9	6	115	13	24	10	7	175	18	10	8	6	55	15	175	7	3	11	25				
1948 Thrushes				50	80	150	200	470	165	15	150	25	20				60			10	12	7	60	250	10					3
1948 Sky	R	Cldy	C	Ptly Cldy	Ptly Cldy	F	F	F	F	F fog	Cldy	Ptly Cldy	F	C	F	F	C	Cldy	Cldy	F	R	R	Cldy	R	Ptly Cldy	C	C	F	C	C
1948 Thrush graph																														
1948 Wind mph	N 5	NW 20	O-WNW	W 5	W 5	W 3	W 5	W 5	SE 5	SSE 5	SW 5	W 5	W	NW 20	NW 15	NNW 20	NNW 5	SW 20	NNW 10	W 5	O	S 5	NE-N 5	NNE 5	NNE 5	NNW 5	NW 10	SW 5	W 5	W
1948 Dawn temperature °C	12	10	6	12	15	17	20	16	185	16	14	9	105	8	7	7	55	105	105	6	11.5	10	7	10	5	-1	14			
1949 Thrushes	80	130	225	152	15	390	30	4		30			225	135	41	10		1	849	548	12	57			196					
1949 Sky	Cldy	Ptly Cldy	C	C	F	Ptly Cldy	C	Cldy	Cldy	Cldy	F	F	C	Cldy	R	R	Ptly Cldy	C	Cldy [illegible]	Cldy	Cldy [illegible]	Cldy	Cldy	Cldy	Cldy	Cldy	Cldy	Cldy		
1949 Thrush graph																														
1949 Wind mph	E 5	O-SW 3	O-NW 3	O-W 2	O-W 3	O-W 3	WSW 5	O-W 2	O-S 5	NNW 10	O-W 5	O-W 5	W 5	O-W 5	O-S 5	O-S 5	W 10	W 20	E 5	E 3	NNE 10	O-SW 5	N 10	N 20	N 10	W 5	O-NNE 5	SW 10		
1949 Dawn temperature	155	warm	65	125	95	19	7	85	12	12	4	65	10	9	16	145	8	12	15	14	7	9	10	14	11	10	3	12		
1950 Thrushes	414	27	83	713	566	429		12	188	110	151	39	2	3	55	280	3	44	66		32	6	2	12			133	3		
1950 Sky	R	Cldy	C	Ptly Cldy	Ptly Cldy	C	R	C	C	Ptly Cldy	Cldy	C Frost	C	C	Cldy	Cldy Snow [illegible]	C	F	Cldy broken	C	Cldy Snow	Ptly Cldy	Cldy R	C	Cldy	C	F	F		
1950 Thrush graph																					Lak Ste Anne									
1950 Wind mph	O-SW 5	–	WSW 10	SW 15	W-S -0	O-SW	W 40	NW 15	SWS -0	W 15	W -0	SW 10	O-W 5	W 5	SW 10	O	W 15	W 15	W 5-20	WSW 5-10	W 0-5	O-SW 3	SW 5-20	O-NNW 5	O-S 2	O-W 10	O-W 10			
1950 Dawn temperature	19	14	4	6	10	4	9	10	11	11	8	3	4	65	10	12	8	5	13	2	-3	-4	8	2	2	25	15	2		

Table 3. Weather data and numbers of migrant thrushes, 1947–1950. C = clear, Cldy, Ptly Cldy = partly cloudy, F = fair.

Which arrived in Gaspé first, the hermit or the olive-back? Since the former is less dependent upon continuous forest and upon insects, it probably preceded the more insectivorous olive-back. Hermits pass through New England in March and April, finding as sustenance over-wintered berries to supplement the earliest insects. Olive-backs follow in late April and May. Possibly temperature in itself is also a factor to which these two species react somewhat differently.

STIMULI INITIATING MIGRATION

Some observations on migratory restlessness in thrushes, and examples of autumn departure, have been recorded above. We may now consider what stimulates these birds to begin southward migration.

Without discussing here the various factors—endocrines, fat deposition, photoperiodicity, and others—that prepare and predispose birds to migrate, a brief statement concerning food status is in order.

During the first half of August adult thrushes and first-brood young feed upon a variety of insects, land snails, and fruits; hermits provide their second-brood nestlings with a diet composed chiefly of insects, garnished with cherries (*Prunus*), shad-berries (*Amelanchier*), raspberries (*Rubus*), and blueberries (*Vaccinium*). Caterpillars, small moths, and orthopteran nymphs have been identified among the specimens brought to the nest. At some date, probably associated with temperature near or below 0°C., the supply of each item will become unavailable. Therefore, with a view to determining the effect of food shortage as a stimulus to migration in thrushes, it is desirable to survey the incidence of temperatures near the freezing point in relation to the onset of migration. From the data now to be presented concerning the relationship of weather to migratory movements, it appears that in some years, at least, thrushes leave Gaspé before low temperature can have diminished the supply of insects and fruit (blueberries, fire cherries).

TEMPERATURE AS A STIMULUS

Without attempting to review here the much considered question of when and how much temperature influences bird migration, attention is called to a recent paper in which this matter is sanely treated by Williams (1950). He cautions against belittling of temperature as a factor and presents examples typical of its relation to migrants already en route or at their destinations.

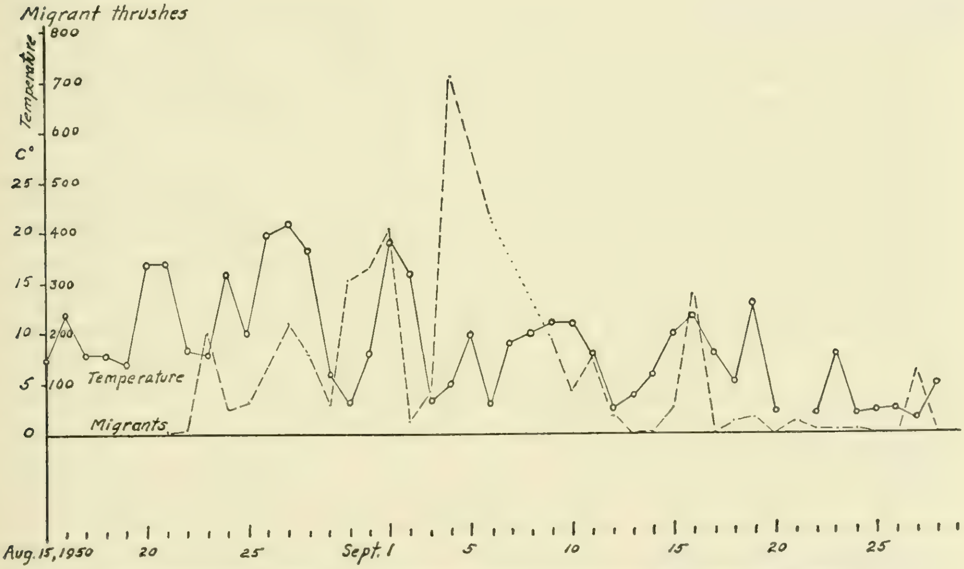


Figure 18. Graph of temperature and thrush flights in 1950.

In the paper on nuthatches (Ball, 1947) the importance of temperature as such in stimulating birds to begin migration was minimized. Study of Table 3 strengthens this attitude; neither high, low, nor change in temperature seems consistently correlated with large movements of thrushes. At an early stage of these Gaspé studies it appeared likely that a relationship existed between low or falling temperature and departure of birds. On the contrary, observations made in 1949 tend rather to confirm the opposite; all heavy movements were recorded when temperatures were from moderate to high (Table 3). If, as many have assumed, coolness incites, or at least accompanies, the onset of migration, then the totals for September 6 and 7 should have been interchanged. Again, meteorological conditions were more propitious on the fresh, clear, moderately warm morning of September 18 than on the cloudy, warm 19th. Yet no migrants were heard on the former, whereas the greatest flight of the year passed down the Cascapedia on the latter.

Figure 18 records graphically the temperature and numbers of migrants during 1950. Here also warm mornings would appear to favor increased migration—an unlikely conclusion. If we attempt to correlate peaks of abundance with cool weather on the first or second preceding day, possibly even lower at a distance, the data of August 27 and September 17 render any generalization improbable.

With a view to discovering a possible relationship between low temperature (less than 7°C.) and the occurrence of marked migratory movements of thrushes from outside the Gaspé Bay region Table 4 was drawn up.

Table 4 presents only those flights which are known to have passed Sandy Beach on the south shore of the bay—probably the majority of thrushes that reached this bay. This seems reasonable because experience on the Forillon and the north shore leads to the belief that nearly all groups traveling eastward along the northern coast of the peninsula as far as Cap des Rosiers enter the Forillon at or near the Break and leave it by way of Grande Grève on their path around the bay.

Of the 40 flights only 11 followed temperatures of approximately 6°C. on the first, second, or third preceding dawn. Disregarding the possibility, or perhaps the probability, that some of the birds would not have made flights on consecutive nights, and adopting a speed of 30 m.p.h., it becomes clear that in one night alone thrushes could easily have flown along the coast from the northernmost point on the peninsula, near L'Anse Pleureuse, or even from Ste. Anne des Monts 156 miles from Sandy Beach. West of Ste. Anne we have found evidence that migration is in the opposite direction (p. 81). The time elapsed would also have permitted northern thrushes, in one night's journey, to span the 70-mile-wide mouth of the St. Lawrence, and reach Sandy Beach by dawn. It is believed, however, that they would have spent more than one day near their landing place on the north shore of the peninsula before again setting forth. At any rate, whether flying at moderate heights above the water and earth, or at the high altitude that has been predicated on observation of birds seen against the moon, the 11 movements cited in the table, from the standpoint of time, may have originated at a considerable distance north or west of Gaspé Bay. However, when we consider that the great majority of the flights recorded occurred when temperatures were relatively high, together with the knowledge that thousands of birds descend the Dartmouth and

Date	*Number of thrushes*	*Dawn temp. Degrees C.*	*Previous temperature*	*Remarks*
Sept. 6, '47	6	18.5	6.5 1 day before	First migrants of the year
14, "	250	7	10.0 1 day before	Descended Dartmouth River to the bay
4, '48	50	12	6.0 1 day before	First migrants of the year
5, "	80	15	6.0 2 days before	
6, "	150	17	6.0 3 days before	
7, "	200	20		
8, "	470	16		
9, "	165	18.5		
10, "	15	16		
11, "	150	14		
12, "	25	9		Down bay, L'Anse-aux-Cousins to Lobster Point
Aug. 19, '49	9	14	17.5 1 day before	First migrants of the year
23, "	15	11.5	9.0 2 days before	
24, "	8	12.5		
28, "	170	16	10.0 1 and 2 days before	
Sept. 5, '49	15	19.5	6.5 2 days before	Heavy migration elsewhere on preceding and succeeding days
Aug. 21, '50	3	17.0	7.0 2 days before	First migrants of the year
22, "	12	9.0		
23, "	205	8.0		
24, "	50	16.0		
25, "	55	10.5		
26, "	135	20.0		
27, "	228	6.5		
28, "	155	18.0		
29, "	64	5.0		
30, "	306	3.0	5.0 1 day before	
31, "	338	8.0	3.0 1 day before	
Sept. 1, '50	414	19	3.0 2 days before	
2, "	28	14		
3, "	83	4		
4, "	713	6	4.0 1 day before	
5, "	556	10	4.0 2 days before	
6, "	429	4	4.0 3 days before	
+	...	...	......	Absent on trip to Tabletop Mountains
9, "	188	11	9.2 2 days before 10.0 1 day before	
10, "	60	11		
11, "	151	8		
12, "	39	3		
16, "	280	12	6.5 2 days before	
18, "	44	5	8.0 1 day before	
24, "	12	2	8.0 1 day before	Last migration along the bay.

Table 4. Movements of thrushes eastward past Sandy Beach, and temperatures recorded on the day of flight and on preceding days.

York valleys before reaching Sandy Beach, any correlation between temperature and migration of thrushes appears at least questionable. Meteorological data pertaining to northern regions would be required.

In 1950 frost occurred every month during the summer; just after our arrival on June 9 (ca. 12), on July 22, 23, up the rivers, August 6, 30, September 4, 6 (frost up-rivers), 12, 13, 14—6°C. (frost up-rivers), 18—5°C. (in hollows) 20—2°C., 21 and 22 (ice at L. St. John), 24—2°C., 25—2.5°C., 27—1.5°C. There were other mornings when the temperature fell below 8°C. at Sandy Beach, and probably resulted in frosts not far up the St. John, York, and Dartmouth rivers. The Fire Guardian at York Lake (1520 ft. elev.) reported frosts on July 22 and 23 when the thermometer registered 9°C. and 8°C. at my home, 150 feet above the bay at Sandy Beach.

It appears, then, that even thrushes nesting near the coast are subjected to low temperatures at intervals throughout the summer. Since migration does not begin until after August 15—the 21st in 1950—we have further confirmation of the belief that cold weather alone cannot initiate migration.

Nor would early frosts be expected to initiate it, for the studies on migratory restlessness (*Zugdisposition*) confirm the natural inference that before migrating birds must have attained the stage in their annual cycle at which an environmental stimulus can cause departure (p. 109).

On the other hand, the following data might be used in support of sudden change of temperature as a stimulus to migration. Table 3 shows that on August 21, 1950, the second successive warm, rainy morning (17°C.), the first evidence of the season's thrush movements was recorded. A sharp fall of 8° brought 12 olive-backs on the 22d, a clear, brilliant dawn. Temperature dropped another degree on the 23d, also fair, when I witnessed an unusually great early-season flight—205. Only 50 were heard on the 24th, when a rise of 8° was registered. Further support may be gleaned from the following good movements on cool mornings—228 on August 27th (6.5°), 306, 338 on the 30th and 31st (3°, 8°), 713 on September 4th (6°). However, caution is necessary before giving much weight here to temperature as a stimulus; other data (p. 106 et seq.) in this long uninterrupted series of daily flights are of doubtful significance.

LOW TEMPERATURE IN RELATION TO FOOD FAILURE AS A STIMULUS

Having found no evidence of correlation between temperature and the migration of local thrushes down valleys, it may be asked whether coastal movements followed the incidence north or west of the Gaspé Bay region of temperature low enough to deteriorate the food supply (p. 92). Data gathered from Table 3 show that, of the 25 most notable movements recorded at Sandy Beach during the four years 1947–1950, five flights followed temperatures below 7°C. by one day, four by two days, and three by three days. Had the birds comprised in these dawn movements been actually on the wing during the full periods of darkness, resting only one daylight period between flights, they might respectively have flown a maximum of 250, 500, and 750 air miles since the low temperature was recorded. However, these maxima probably are seldom achieved over the ground. Furthermore, the birds, unless employing the questionable high-stratum type of flight, would not have followed a straight course; nor, as suggested above (p. 55), would they have utilized the entire night periods in flight. Therefore the areas over which the stimulating cold air may be supposed to have lain in these instances were doubtless much nearer to Gaspé Bay than, for example, the region south of Lake Mistassini (280 miles) or the tree-limit in Ungava (500 miles). A coastal route of 750 miles may be postulated for a thrush leaving the eastern shore of Labrador, passing around Belle Isle and crossing Anticosti to Gaspé. The other 13 flights were associated with moderately cool to very warm weather. Limiting attention to the first movements of these years, we find one occurring one day after 6.5°, one two days after 10°, and one when temperatures had remained at least 11° above freezing. Interpretation would profit by knowledge of the actual origin of the migrants.

From the above discussion the late September movements in western Gaspé have been omitted. More observations are required to complete the picture of autumn migrations in the Ste. Anne and Cascapedia valleys. Certain aspects and details appear elsewhere in this paper (pp. 80, 85).

Although Table 3 strongly indicates that, for this part of the peninsula, the majority of the migrant thrushes were heard, still one feels the need of records from September 20–26, 1948; September 18–25, 1949; and September 7–8 and 20–22, 1950. One disadvantage of leaving northeastern Gaspé in order to study thrush behavior in other localities has been the interruption of records taken about the bay. Judging by the small numbers heard after returning to the home base, these periods probably saw rather few migrants. The following incident supports this conclusion. September 13, 1950, on a trip to Beaver-dam pool far up the York River only 2 thrushes were heard, even though the sky was clear and frost had formed—withal an excellent morning for migration. Equally unpredictable, on the other hand, was the good flight (133) recorded 14 days later on the St. John–Grand River divide—a rare occurrence so late in the month.

It has been shown (introduced on p. 71) above that in 1949 migration began on August 26 before any really cool weather had occurred, whereas in 1947, when temperature was relatively low, the first important movement was delayed until September 7. In other words, the patterns of these two years not only contradicted each other but also the migratory behavior that would be expected of the birds if low temperature, acting directly or indirectly through food reduction, were the stimulus to departure for the south. By the same tokens these observations imply an earlier disappearance of active insects, and deterioration of fruit by frost in 1947 when migration was late, and vice versa in 1949. Taken alone, this nonconformity indicates that a decline in the availability of customary food cannot be a major factor in initiating migration of local thrushes. Furthermore, it is well known that as their animal food (insects, earthworms, salamanders) becomes less available in late summer and fall, thrushes depend to an increasing degree upon wild fruit. Twomey (1945) found the diet of the wood thrush (*Hylocichla mustelina*) wholly animal in spring but 30 per cent wild fruits in autumn.

Diminution even in the supply of vegetable food within areas heavily populated with birds certainly occurs. For example, one important and conspicuous item is the fire or bird cherry (*Prunus pennsylvanica* L.). Thrushes feed extensively upon these small, bright red fruits, and visibly deplete the supply through late August and early September. Since these small trees, though common within the feeding territories of some thrushes, are fewer in others, the occupants of the latter may conceivably be stimulated to leave these territories for more productive ones, or even to migrate. It is evident, however, that the crop of blueberries, usually abundant in Gaspé, and even more favored than cherries by thrushes, would satisfy their needs and inclinations even after frosts have altered the acceptability of the food to man. It is the pulp, rather than the "stones" and seeds of cherries and blueberries, that attracts these birds. As a matter of fact, thrushes, and especially robins, seem to relish frozen blueberries that have long since dropped to the ground.

The reduction of food locally, with the resultant shift of resident thrushes to other feeding areas, raises a question of definition. When does dispersal become migration? This question does not arise in the case of colonial species like cormorants and gannets. As described above, the cormorants leave their cliffs in groups of considerable size and strike out for the south in a manner that gives every indication of vigorous migration. On the other hand some passerines, for example white-winged crossbills and cedar waxwings, fly erratically back and forth, up and down the Forillon, taking food where they find it. And the Canada jay that nests chiefly in the interior forests disperses to the coastal margins in the autumn.

Considering now the Gaspé thrushes, it has been stated that, for instance, on the Sandy Beach plateau hermits and olive-backs have been watched on territories throughout their residence and late summer molting period. On a given date, say August 25, the bird is present; the next morning its haunts are vacant. It is therefore assumed that during the intervening night the bird departed upon its migration.

But one is ignorant of the distance flown; neither the times of departure nor of alighting are known. As previously calculated, if a thrush leaves the ground in the evening and flies till dawn at the rate of 25 m.p.h. it may cover 225 miles. We have seen, however, that not all thrushes depart in the evening twilight period; some have been recorded springing into the air between midnight and the beginning of astronomical twilight (p. 67). Furthermore, in these Gaspé studies descent to the ground before dawn under clear night sky has not been deemed improbable. Some thrushes may not fly more than a few miles. While the above-cited resident of the Sandy Beach plateau was descending to feed in New Brunswick, assuming that he flew until dawn, his place may have been taken by another that rose during the night from its own territory near by somewhere in the Dartmouth Valley. Since each bird made a journey directed more or less straight southward both may be said to have "migrated." The validity of this term, as applied to the second example, is enhanced by the fact that, like migratory movements of many hours' duration, its flight was nocturnal. On the other hand a shift of merely 100 or 200 meters to a new feeding territory in late summer, as witnessed on several occasions, is accomplished diurnally. Defense of this territory by an occupant already in possession has been observed. Unlike their relatives, the robins (*Turdus m. migratorius*), thrushes of the genus *Hylocichla,* as far as known to the author, do not assemble in fall flocks before migrating. Until the time of departure they have been found in groups no larger than the family. Indeed, the unit commonly observed comprises only the surviving young of a brood. An example is the 4 juvenile hermits encountered morning after morning during late August and early September, 1950, in the triangular grove of conifers that terminated the unburned forest back of Sandy Beach. They were heard and seen feeding among the trees and shrubs, as well as in the brakes and blueberries of the adjacent burned area. Finally came a morning when they could not be found; they had left, apparently without joining other birds while in their coverts. Thus far, limited attempts to discover how thrushes become associated in the loose flocks heard migrating down valleys has been unsuccessful. Indeed, fortune has been kind in permitting observation of even a few individuals and small parties as they have taken flight.

The short diurnal movements of warblers, sparrows, and other passerines as they pass from bush to tree is a generally recognized feature of migration. Though frequently reversing their direction briefly in the search for food, the resultant progress of the birds' daily activity is toward their ultimate goal. This may not seem to deserve the term "migration," for the reason that it is carried on chiefly as a series of feeding movements, in daylight, by birds known to perform their chief migratory movements at night.

Justification of this attitude may be found in the above recorded diurnal movements of robins and warblers northwestward along the south shore of Gaspé Bay and up the St. John and York rivers. In direction, these are opposed to the customary nocturnal flights of thrushes during migration, and, as previously surmised, may be concerned chiefly with the search for food—another example of ecologic compulsion (Schüz, 1950).

In view of the above considerations it seems permissible to regard both the ordinary diurnal and nocturnal movements as, in some degree, migratory.

One more bit of grist may be supplied to the mill which grinds out food for thought, if not, as hoped, for the truth concerning the relation of food shortage to migration. On one morning early in September an olive-backed thrush for the first time was missing from its long-occupied territory, a narrow strip of woodland near Sandy Beach. This was quite within the normal program, for other olive-backs left on this date. The unexpected development was that a hermit, not previously observed here, now occupied this territory. The fact that it remained three days is interesting in several respects; the one that relates to our discussion of food is the possibility that the diet of the hermit differs sufficiently from that of the olive-back to permit the former species to remain comfortable in an environment forsaken by the latter. An answer must await careful dietary studies. At present the earlier migration of olive-backs is not believed to be correlated with food preferences.

Further remarks on temperature in relation to migration appear beyond (pp. 105 ff.) under "Four years of migration in relation to weather."

FLIGHT PERIODS AND WEATHER

Attention may be called to several periods during which certain patterns may be discerned in the numbers of migrants. Early in the 1949 season two series declined from initial maxima (Aug. 23–25 to Aug. 26–30); similar is the series of September 6 to 8. From August 30 to September 5 a rather symmetrical rise and decline was recorded. Doubtless another series of this sort extended from September 11 to 17. The morning of the 12th was so favorable for migration that many thrushes should have passed. Unfortunately I awoke too late (5:10 A.M.) to observe during the twilight period when migrant thrushes are usually vocal. The almost complete absence of ground calls on the Sandy Beach plateau (1 olive-back) indicated that I had not, after all, missed many migrants. Furthermore, it may be noted that no dawn flight occurred at Cap des Rosiers and Griffin Cove portage on a subsequent quite favorable morning, September 17. This loses cogency by its position between the series of days just considered and that of September 18 to 21.

This last series opened along the Bay of Chaleur with a clear morning marked by fresh west wind and moderate temperature. Bonaventure was the locality, but no thrushes descended the river or crossed its mouth coastwise. A single olive-back called after dawn from the woods' margin near the east bank of the stream. The experiences of the following three days aroused regret that observations could not have been made at Maria near the mouth of the Cascapedia instead of at Bonaventure. For, if 850 and 550 thrushes passed down the former at dawn on the cloudy 19th and 20th, and 450 passed Maria in the evening of the 20th, it would be interesting to know what occurred on the 18th.

The series of September 6–8 may be regarded either as extending the preceding period or as a brief one that began with a strong flight of 390 thrushes down the Dartmouth.

For comparison with behavior of nuthatches (Ball, 1947) in periods of fair weather attention may be drawn to August 21–31, 1949. The first strong migration of thrushes (115) came on August 23, the third fair day of fresh to light west winds. Showers fell next morning; only 8 thrushes passed. None was recorded on the 25th, although fair, with winds again light, west. A truly great flight (650) poured out of the York Valley on the

26th, cloudy but light wind still westerly. One hundred and eight birds passed Sandy Beach on the 27th, clear and calm, and 70 on the 28th, still calm, but cloudy. Although the 29th was warm and rainy, 20 thrushes were recorded but none called on the 30th, a very warm morning with light rain and fresh south-southeast winds. Again September 2 to 7 provided good migration weather that brought sustained flights.

The conspicuous exception to the "fair weather rule," to which attention has already been called, was the 2-day migration out of the Cascapedia Valley on September 19 and 20. This included the strongest evening movement as well as the greatest morning movement of thrushes yet recorded in Gaspé. Both days were heavily overcast with intermittent rain and easterly winds. Further data on the weather at this time appear below in the consideration of atmospheric pressure.

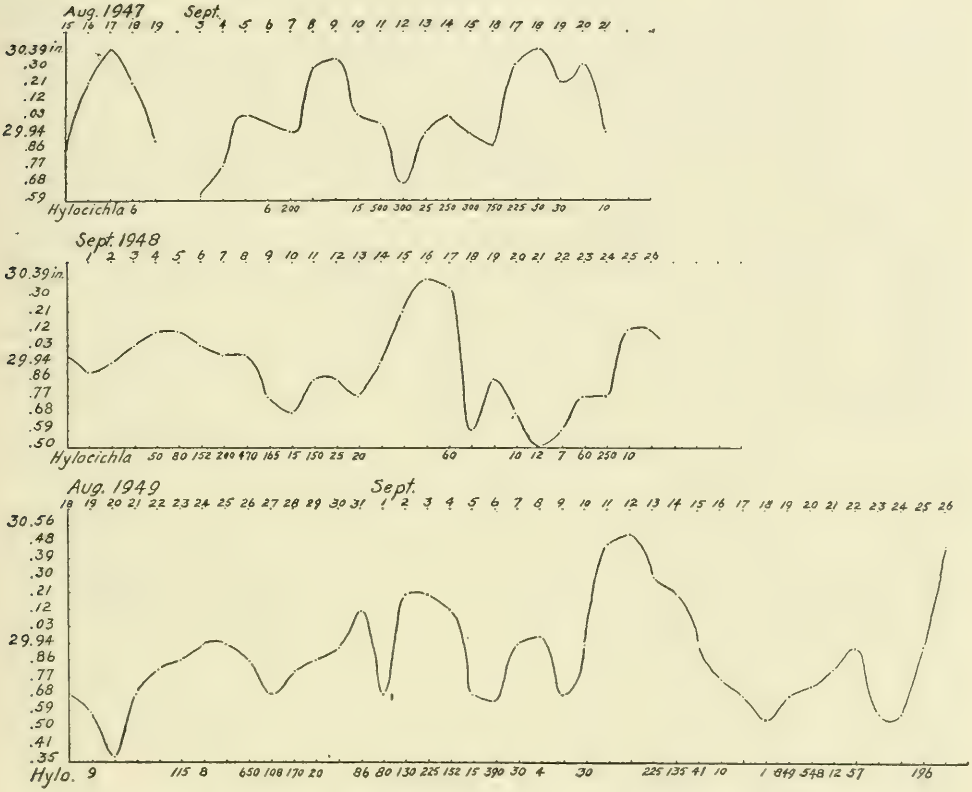


Figure 19. Graphs of barometric pressure in 1947, 1948, and 1949.

ATMOSPHERIC PRESSURE AND THRUSH MIGRATION

Without conceding any influence of atmospheric pressure upon bird migration except indirectly as it controls temperature and winds and thereby humidity, in other words, *weather*, graphs (Fig. 19) are provided to show the distribution of pressure and the more important movements of thrushes in 1947, 1948, and 1949. Although several great flights passed on mornings of low or falling pressure, others occurred when it was steady, rising, or high. For example, in 1947, the first heavy movement (200) came on September 7 after three days of steady moderate pressure; 500 passed on the 11th after two days at about 30.00 inches, 200 on the 14th, and 225 on the 17th, when pressure was high and rising. In 1948 the first flight passed during a high pressure period, and the greatest of the year on the 8th when pressure had been steady for two or three days. Similarly in 1949 the first large movement occurred on August 23 with rising pressure; two other good flights passed on September 2 and 3 when pressure was high. Curiously enough, August 31 and September 1 brought the same numbers of migrants, the first accompanying a sharp rise and the second a sharp fall.

While working in the Ste. Anne des Monts region in 1948 a low pressure center passed over Gaspé on September 21. It was followed by a broad Polar High that slowly progressed from Saskatchewan, reaching James Bay on the 23d. There it was held stationary by a hurricane that during the period from September 21 to 24 curved northward through Florida, then northeast off the Atlantic coast. The high center intensified to 30.56 on the 25th but remained in the Moosenee area. On slowly rising pressure (29.50, 29.59, 29.77, 29.77) rain fell in Gaspé on September 12, 22, 23, and early on the 24th. Cloudiness continued through the 24th but cleared somewhat on the 25th as the pressure rose to 30.12 and held through the 26th.

Now, from September 20 to 26 migrant thrushes were recorded as 10, 10, 3, 64, 293, 12, 3. Pressure was rising (Fig. 20).

It is to be emphasized that during this entire period no fronts crossed eastern Quebec. There is no reason to believe that any of these birds came into the region on high-level winds. Field evidence wholly supported the belief that those heard descending the Ste. Anne were leaving their home in the Shickshocks and would eventually find their way southward via the south shore of the St. Lawrence. The 138 thrushes that ascended the Ste. Anne on September 23, 24, and 25 may have been seeking a southward avenue through the mountains after having come down to the coast from the mountains lying east of Ste. Anne des Monts.

The autumn of 1949 furnished strong evidence that atmospheric pressure in itself does not stimulate thrushes to migrate. Good flights were recorded on falling as well as rising gradients. Both are shown in the period from August 21 to 27 (Fig. 20). Pressure was beginning to rise (29.86) over Gaspé at dawn on the 22d as a low was receding while a cold front west of the St. Lawrence was approaching. A single migrant was heard in the evening. On the 23d a slight rise (29.86) accompanied this front, now recorded on the weather map as "stationary" over northern New Brunswick. One hundred and fifteen thrushes passed eastward over Sandy Beach. Pressure rose slightly again on the 24th (29.94) toward a high over Moosenee at the southern end of James Bay. Only 8 migrants appeared. None passed on the 25th, pressure being about the same (30.00). A fall, begun

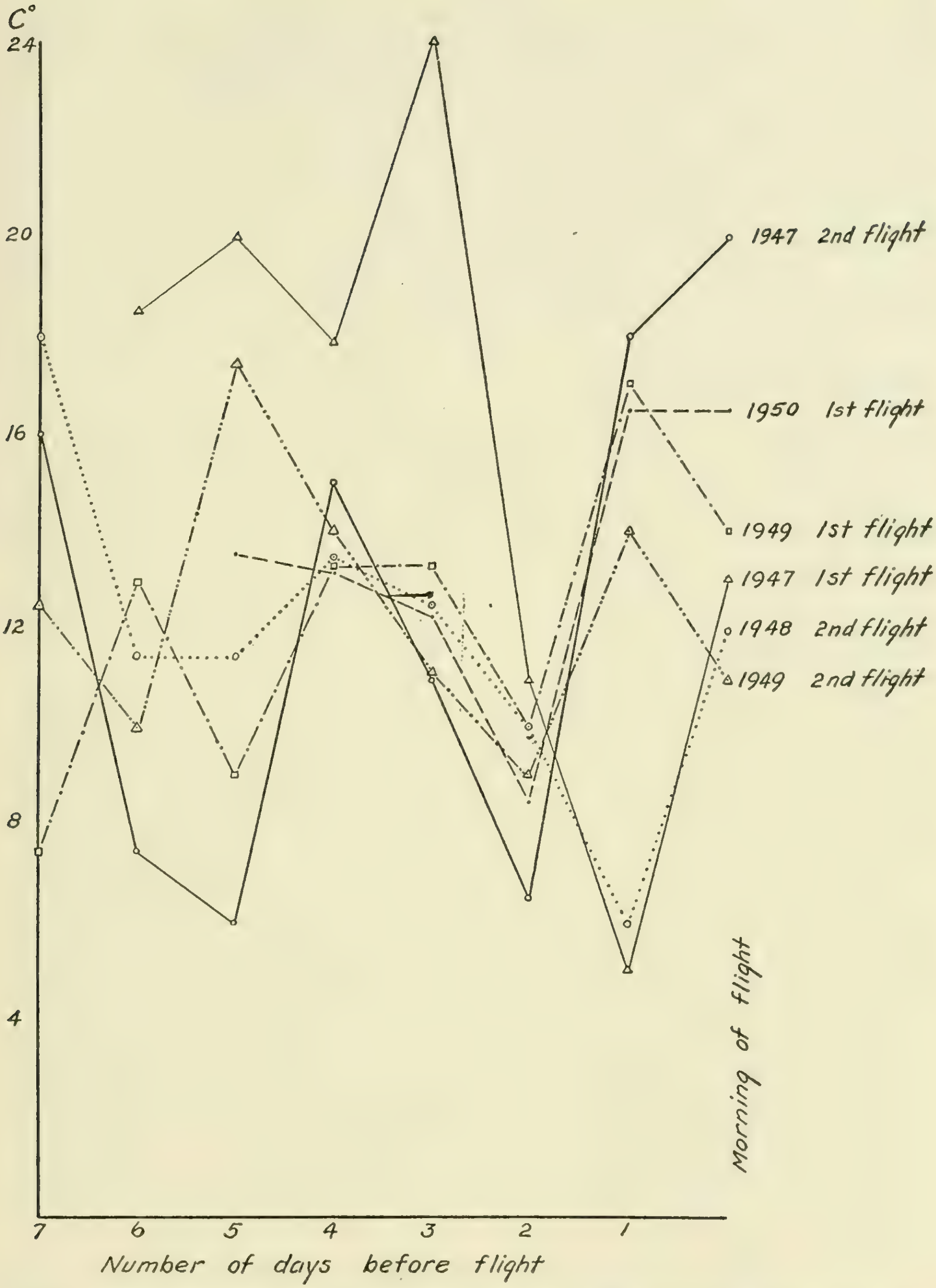


Figure 20. Graphs of temperature on mornings of first seasonal flights and preceding dawns.

in the evening, continued through the 26th (29.80) as a low cool front approached from the north-northwest, overtaking a weak warm front (Fig. 27, Appendix). Winds at the ground surface were light from the west. The morning was marked by a heavy flight down the York River valley—650 thrushes. This movement continued on the calm, clear 27th (108 birds), the cool front having passed over eastern Gaspé late in the night. Pressure had fallen to 29.68, and a second cold front was closely following from the northwest (Fig. 27). The 70 migrants passed Sandy Beach on the 28th, again calm, cloudy, and warm (16°C.) as the low crossed the peninsula, curiously enough still marked on the map as a cool front. The map of the 29th, however, has it properly drawn as a warm front, the temperature having risen to 20°. Pressure also had risen somewhat during these two days (29.80, 29.86).

Again migration on falling pressure occurred September 13, 1949 (Fig. 28, Appendix). A "high" entered the Maritimes on the night of the 10–11th (30.56 at Gaspé, 4°C., frost in the hollows) and moved but little to the eastward during the next 24 hours. Pressure had begun to fall on the 12th (30.50, again frost), and continued downward on the warmer 13th (30.30) and 14th (30.21). Two hundred and twenty-five thrushes left the York Valley on the 13th and 135 on the 14th. The slowly moving high center was now just leaving the Nova Scotia coast, while an extensive low (29.68) occupied the region west of James Bay.

To the examples of migration on rising pressure we can add the great movements out of the Cascapedia Valley on September 19 and 20, 1949. It is probably safe, as explained elsewhere, to regard the 450 thrushes that passed Maria in the evening of the 20th as a continuation of the morning's flight witnessed on Brandy Brook, one of the upper tributaries of the river. At Bonaventure the 18th dawned clear, 11°C., wind west–20. Although the morning seemed propitious for migration no movement of thrushes occurred. A single olive-back fed in dense cover near the east bank of the river, while a few myrtle warblers and robins passed westward. Rain entered the peninsula on the evening of the 18th before a warm front and low of 29.50 (Appendix, Fig. 29). This was being overtaken by a cool front (cf. p. 194) that crossed Gaspé before dawn of the 19th, leaving low clouds and fog mantling the mountains. Pressure was rising (29.68) and the temperature higher as the cold front moved on to Cape Breton. Eight hundred and fifty thrushes descended the Cascapedia at Lazy Bogan. Another low center north of Toronto moved rapidly into Gaspé on the 20th, causing general rains, though pressure was rising (29.80) toward a high center over Ohio. This was continued south of New England while a marked low warm front progressed eastward over James Bay.

Again evidence is lacking that on the 19th and 20th these Cascapedia thrushes were brought into the valley on high-level winds carrying warm air from areas beyond the St. Lawrence. Wind from the northeast was light at the ground level, and the cloud layer moved very slowly. See also Appendix for weather maps and statement concerning cold fronts.

Another instance of migration on rising pressure was the last movement recorded in 1949—196 thrushes flying southwest behind St. Octave at dawn, September 25 (p. 81). In this case the rise was steep, and continued through the following day (Appendix, Fig. 30). After a low "stationary front" slowly passed through Gaspé on the 23d (29.59 at dawn but lower during the preceding night) the rise had begun before dawn of the 24th (again 29.59) as the low center slowly receded eastward. The temperature was moderate (14°C.), light rain still fell, the wind north 20 m.p.h. The rise in pressure continued as a broad high approached from the southwest into New England. At dawn on the 25th, when these birds were recorded, it had attained 29.90. The clouds were still moving from the north after a rainy night. One is tempted to ascribe to the low of the two preceding days, accompanied by much drizzle and rain, the total absence of migrants in the Ste. Anne region. However, this inactivity is in agreement with the usual behavior of thrushes, nuthatches, warblers, and other birds in Gaspé; they migrate most freely on fair mornings. Probably the rise in pressure, begun on the 24th, caused a slight improvement in the weather, sufficient to set in motion thrushes that were already late in starting and doubtless near the threshold of migration. As previously expressed, the impression gained was that these 196 birds had descended the Ste. Anne River from the Shickshocks. Judging from the winds and temperatures recorded in the field, and from data provided by weather maps, there is little indication of high-level winds that would have carried into the peninsula thrushes from areas north of the St. Lawrence. At the same time it is true that the morning of the 25th, though calm at the ground surface, was characterized by low stratus clouds slowly moving over the region from the north.

While casual inspection of the graphs (Fig. 20) may lead to the conclusion that migration is heavier on mornings of low or falling pressure, the exceptions to which attention has just been drawn cast grave doubt upon the effectiveness of pressure in itself. When one sees gulls within a few moments ascend 1000 feet from the waters of the gulf to the top of Mt. St. Alban and return again to rest upon the waves, he is driven to doubt whether the same or other birds are likely to be stimulated by an even lesser change in pressure experienced during the passage of a "low" or "high." The pressure would fall 1 inch of mercury between the foot and top of St. Alban, whereas it dropped less than 1 inch (30.56 to 29.68) between September 12 and 17, 1949, and only from 30.33 to 29.68 between September 9 and 12 when two heavy flights were recorded.

FOUR YEARS OF MIGRATION IN RELATION TO WEATHER

In considering the dates and numbers of migrating thrushes during the years 1947–1950 it should first be pointed out that, although records were made at dawn each day, the localities differed. All were made in northeastern Gaspé except during the periods September 20–26, 1948, and September 23–25, 1949, spent in the region about Ste. Anne des Monts, September 18–22, 1949, and September 7–8, 20–22, 1950, when I was studying the Bonaventure, Cascapedia, and Matapedia valleys, and on Tabletop and about Lake Ste. Anne. Omitting these dates, Table 3 brings out the relative lateness of migration by thrushes in 1947 and its earliness in 1949 and 1950.

Do the data indicate any correlation of weather factors with these migration movements? First, if cumulative low temperature were the stimulus, thrushes should have left earlier, instead of later, in 1947 than in the succeeding years, for the respective average temperatures during the period August 17–September 2 were 10.9°C., 13.5°, 13.4°, and 12.5° in 1950. In 1947 unusually cool weather prevailed from August 27 to September 2; yet no important movements were recorded until September 7. In 1948 the temperature failed to drop below 10°C. until September 3—a sudden fall to 6°, followed by immediately warm weather. If one regards this low temperature (first frost in low areas) as the stimulus that set in motion the strong migrations of the following six warm days, he will then have difficulty in assigning a stimulus to the sudden, strong, and very early migration on August 26, 1949, during mild weather. Temperatures on the four preceding days ranged from 11° to 14°C. Recourse to areas far distant would be required. Indeed, all movements in 1949, except that of September 3, passed during warm weather. This was true of 1947 and 1948 as well. Even in the unusually cold year, 1950, three of the five greatest movements occurred on relatively warm mornings. No consistent relationship appears between temperature and migration during September. Average temperatures for the period September 3–26 in these four years were 10.4°C., 10.3°, 11°, and 7.4°. But the bulk of migrants as observed at Sandy Beach passed between September 6–18, 1947; September 4–12, 1948; August 26–September 15, 1949; and August 23–September 17, 1950. Although the average temperature was higher, the 1949 migration was earlier than those of 1947 and 1948, contrary to what would have been expected were low temperature a factor. The birds of 1950, on the other hand, support this hypothesis—low temperature, early migration of the majority.

Omitted from the above discussion was the early flight of 6 thrushes that passed Sandy Beach on the morning of August 18, 1947. This was done because of their appearance so far in advance of the year's chief movements; at least one hermit was still incubating her second clutch of eggs here. We should not fail to note that the migrants appeared but a single day earlier than the first migrants of 1949. The latter, however, were soon followed by others. Attention may also be called to the fact that these 1947 birds left only 24 hours after the first frost of the year had appeared in the hollows. Before concluding that low temperature was the stimulus we should also note that in 1949, long before any hint of frost occurred, at low altitudes, 9 migrants passed Sandy Beach on August 19. If these are to be used in support of temperature as a stimulus they must be assumed to have come from farther north or a higher altitude.

It was quite apparent, then, that the early and important local movements of 1949 were not due to temperature.

Having in mind the possibility that seasons with low average temperature during the period of 4 to 21 days preceding the first migration flights might have the earliest movements of thrushes, and disregarding the first 6 birds recorded in 1947 followed by a long interval of 19 days before consistent movements began, the following tabulation is extracted from Table 3:

Date	*Avg. temp. Aug. 16— first movement*	*Date first movement*	*Avg. temp. Aug. 16–Sept. 6*	*Temp. first flight A.M.'s*
1947	11.3°	Sept. 6	11.3°	18.5°
1948	13.1°	Sept. 4	13.3°	12°
1949	13.5°	Aug. 19	13°	11.5°
1950	16°	Aug. 21	11.9°	17°

Table 5. Temperature in relation to the first migrational movements of four successive years. Provides the average temperatures from mid-August to the date of first-flight, and also to September 6, the latest date of first-flight. Temperatures of the mornings on which earliest movements occurred are shown.

These data show, if anything, that the extremes in average temperature (1947, 1950) brought the first flights on dates opposed to those expected on the low temperature basis. For comparative purposes the average temperatures from August 16 to September 6 are provided. In other words, if the first migrants in 1950 had waited till the date of the 1947 birds, the temperature would have been nearly identical and warm; but the first-flight mornings in 1948 and 1949 were much cooler (Table 3).

It is apparent from Table 5 that in 1950, with average temperature (Aug. 16–Sept. 6) the same as in 1947, the majority of migrants had already passed before September 6, the date of 1947's first movement.

It may also be noted that the temperature at dawn when the first annual fall-flights passed also fails to confirm low temperature as an immediate stimulus to migration. Figure 20 illustrates this on the days of first-flights and 24 hours earlier. But the fact that a drop occurred in Gaspé two days before each flight may suggest to some readers that low temperatures north of Gaspé set birds in motion.

Most students of hormonal control of cyclic changes in the gonads have examined the relationship of temperature to them. Rowan (1931) held that secretions of the sex glands control migration behavior, but that light rather than temperature is the fundamental external factor. In his 1938 review, Rowan explained that familiarity with the field behavior of migrants in the northern hemisphere influenced him in 1924 to regard as highly improbable the commonly adopted view that the annual rhythm of the avian gonad depended on seasonal changes of temperature. So hopeless did this appear to him that he never attempted to apply it experimentally, but in his classic work turned to the manipulation of the length of day by means of artificial light. Bissonnette (1930–1933), Benoit (1936), and others have supported Rowan.

Even earlier, Rowan (1929), observing a remarkable southward flight of ducks in Alberta, concluded that falling temperature and exceptionally high barometric pressure were incidental, not fundamental factors. Burger (1949) found at least no prohibitive effect by external temperature in most birds tested for spring gonadal response. One may expect it to exert no more effect in autumn when the gonads have regressed and migration occurs.

Kendeigh (1934) found temperature plus hours of darkness the critical factor for survival at low temperature under starvation conditions. But he probably would not have expected this to apply in late summer and early autumn when food was plentiful. Indeed, he later (1941) wrote, "All the evidence from these experiments (on gonadal development and egg-laying) indicate that the development of the gonads is not controlled by lengthened periods of wakefulness, added exercise, longer periods of feeding, or temperature but by some influence exerted by the lengthening light periods themselves." There is no reason to believe that regression of the gonads in autumn is effected by temperature.

Bissonnette (1937) agrees with Kendeigh that climate includes factors of major importance in controlling migration, distribution, abundance, and behavior responses in many birds—and adds that, of these factors, changes in duration, intensity, and even in the wave-length of light with the seasons, and the development of refractoriness to activating factors, are for many species of paramount importance.

Marshall (1942) regarded temperature, among other factors, as playing some part in modifying the activity of the endocrinal system, and says that, for some species, it is known that one or more of these factors may be the primary controls, and not the length of day.

Blanchard (1941) suggests that at least for the Nuttall sparrow (*Zonotrichia leucophrys nuttalli*) the gonad cycle is influenced chiefly by annual rhythms in mean temperature. But the glandular cycle she holds to be directly timed by an inherent physiological rhythm which is subject only to partial modification by temperature and other external factors. Nice (1933) believed the autumn migratory urge of song sparrows was modified by falling temperature and high barometric pressure. However, the migratory instinct appeared to be latent in some individuals and normal in others.

In the excellent review of researches upon the relation of endocrinology to the study of migration phenomena given by Beach (1949) he points out that both Thomson (1936) and Wolfson (1945) regard the general physiologic state of great importance, and that such features as fat deposition contribute heavily to migratory behavior. Wolfson went further, holding (1945) that both external and internal factors are operative, and that the internal stimulus is due to secretory activity of the pituitary, exerting a direct behavioral control (1942). He regarded gonadal recrudescence merely as one concomitant of increase in pituitary secretion which probably also affects the adrenals and thyroids.

Wolfson (1945) could not agree with the implications of Nice's (1937) statement that a steep rise in temperature in late February will strongly stimulate some male song sparrows to migrate, or to similar implications that migration is regulated by weather. But he in effect merely conditions this regulation upon nervous control. "Only when the nervous control of migratory behavior has been released can weather influence the initiation or continuance of migratory flight." Also, when the internal stimulus has induced a migratory movement, bad flying weather will not necessarily stop it, even though death of many birds will ensue.

Odum (1949) reviewed the observations of Nice (1938), Baldwin and Kendeigh (1938), Wolfson (1942, 1945), Linsdale and Sumner (1934), and others on fat deposition in passerines. Merkel (1937) in Breslau found *Sylvia communis* and *Erithacus rubecula* showing restlessness only after reaching maximum weight; it disappeared when they lost weight, but reappeared when they regained it. Interpreting the results of his experiments with white-throated sparrows, Odum attributed the heavy deposition of fat in midwinter to the influence of temperature. Although not examined, the gonads at this time probably were still in the regressed state or in the early stages of recrudescence. It is especially interesting that the birds did not migrate then. Since they do leave their northern breeding range in autumn when they are also fat and their gonads are in the regressed condition, migration cannot be due to the presence of fat alone. Neither would fat deposition in late summer and in fall necessarily be due to temperatures that are much higher than in midwinter. Therefore we may turn for the answer either to the direct influence of light and its changes, or to other factors working through the pituitary. Wolfson and Odum are jointly continuing their studies of *Zonotrichia.* Further consideration of Odum's research appears beyond in the appraisal of light as a factor in migration.

During the few weeks of the fall migration season birds that are nearly or completely conditioned to begin their southward flight are subjected to different intensities of meteorological factors. Some individuals may have higher thresholds than others to these factors or stimuli. It has been shown above that, with respect to the initiating of flights, generalizing as to efficacy of wind, rain, cloudiness, pressure, and temperature is unwise—almost impossible. Examples supporting or denying the importance of various factors have been adduced in this paper. At the same time it must be admitted that extreme conditions do result in the disappearance of some species. For example, a severe southeast gale and rain storm on September 1 and 2, 1941, cleared from the Forillon all redstarts (*Setophaga*), black-throated green warblers (*D. virens*), and many blackpoll warblers (*D. striata*). Although as yet unproved, that other birds at later dates, or under milder conditions, migrate as a result of lower intensities of wind, etc., seems probable.

An analysis of the meteorological conditions pertaining to the four instances (p. 67) in which thrushes were heard departing on migratory flights was made in an attempt to discover the immediate stimuli that set them in motion. The 2 hermits that left Madeleine Fork as dusk was settling at 7:50 P.M., September 10, 1941, had just experienced a day that began completely cloudy at 4:00 A.M., with winds northwest 2 m.p.h. at 4:15 A.M., northeast at 7:00 A.M., and southeast-east at 8:45 A.M.—temperature 10.5°C. at 4:15 A.M. The clouds broke somewhat at 5:30, allowing the sun to shine intermittently during the day. The evening was again cloudy but calm, as another moderately low-pressure area moved into Gaspé from west-northwest—29.94 in. at Sandy Beach and falling. Next morning was foggy with a complete cloud layer still coming from south-southeast. Associated with the departure at York Lake, September 7, 1941, 3:46 A.M., the sky was cloudy, wind southeast—3 m.p.h., 10.5°C. as a low was crossing Gaspé—pressure 29.68, just before a rise began in front of a high near James Bay. On the third instance—Sandy Beach plateau, September 6, 1949, 2:16 A.M.—the sky was partly cloudy, wind west—3 m.p.h., 19°C., after three fair days with light westerlies. A low (29.68) with a "cold" front was passing, and pressure just beginning to rise toward a high area over the Great Lakes. Again, at Sandy Beach, September 18, 1950 dawned mostly clear at 4:30, gusty to west—15 m.p.h. In the late afternoon clouds gathered, nearly covering the sky at 6:00. Clearing began at 6:30, and by 6:53, when the thrush departure occurred, only scattered fracto-stratus were drifting over from the west. Pressure was 30.03, falling toward a low center (29.77) south of James Bay. Tabulated, these four cases meteorologically are as follows:

Date	*Time*	*Sky*	*Surface wind*	*Temp.*	*Atmospheric pressure*	*Light intensity*
Sept. 7, '41	3:46 A.M.	cloudy	SE–3	10.5°	29.68 just before rise	0.00005 f.c.
Sept. 10, '41	7:50 P.M.	cloudy	calm to 5	15° in eve.	29.94 falling	0.0150 f.c.
Sept. 6, '49	2:16 A.M.	partly cloudy	W–3	19°	29.68 beginning to rise	0.0025 f.c.
Sept. 18, '50	6:53 A.M.	fair	gusty to W–15	18°	30.03 and falling	0.0050 f.c.

We find little here that is helpful in determining what may be the immediate stimuli that elicit the migration response. Partial consistency appears only in the relatively low pressure pertaining to at least three instances. One cannot say that all departures occurred in fair weather following cold fronts.

Drost (1931) concluded that *Calidris alpina, C. canutus,* and *Merula merula* departed on migratory flights at light intensities rather uniform for each species; and Wagner (1937) found 0.083 meter candle (0.273 f.c.) most favorable for the onset of migration restlessness in the redbreast (*Erithacus rubecula*). Quite different, as above recorded, was the range of light intensities under which these four departures from Gaspé occurred. In one instance, at 7:50 P.M., the sky was cloudy, the moon in the third quarter one hour and thirteen minutes before rising. The location from which the thrushes arose was at the juncture of Madeleine Fork and the York River in a deep valley where darkness arrived early. Five minutes before they took flight, it was still possible (0.015 f.c.) to discern the moving silhouettes of 2 thrushes among the trees at the forest margin. The other evening episode took place at 6:53 P.M., but a week later in September. Scattered clouds allowed a 40 per cent illuminated moon high in the western sky to increase the light intensity to 0.005 f.c. Of the morning departures, one, 2:16 A.M., September 6, occurred under a moon 35 per cent illuminated, at about 45° elevation in the western sky. Scattered clouds prevailed permitting a photometer reading of 0.0025 f.c. The other was made under much darker conditions, at York Lake, 3:46 A.M., September 7. Heavy clouds intercepted most of the light from a moon 98 per cent full, elevation about 75° from the western horizon. The meter barely registered a sky illumination of 0.0002 f.c.

The range of light intensity under which these four Gaspé thrush departures were made thus appears to be much weaker and of greater extent than those recorded by Drost and Wagner. Indeed, one of the morning flights began under truly "dark" conditions, although the sky was somewhat brighter than the earth. The very fact that call notes were uttered by these birds serves to confirm the episodes as true departures, for as recorded above, thrushes seldom call during the night, but become remarkably vocal as the dawn light reaches intensities exceeding 0.002 f.c., and the migrants are stimulated by factors associated with descent for feeding. It is inferred that thrushes leaving the ground are equally excited and therefore utter the strong notes heard on these occasions.

In so far as the data already obtained in Gaspé indicate, one may entertain the hypothesis that the earlier the nesting season of thrushes, the earlier occur the first movements, as well as the departure of the majority of migrants. Judging from the distribution and intensity of song by territorial males, the season of 1948 was a week later in the case of olive-backs than in 1949, and 10 days later for first emergence of hermits (June 30); second brood, July 31. In 1949 the first brood of hermits began leaving the nests on June 26, and the second brood on July 24. The emergence of the first brood was not recorded in 1950, but the second brood left the nest July 26, at least five days earlier than in 1948. Table 3 shows that the first migrants passed 12 days later in 1948 than in 1949, although the average dawn temperature from August 16 to 31 was the same (13°) for the two years. Possibly the juveniles of 1949 may have reached, earlier than those of 1948, the physiological condition at which the proper stimulus could elicit a departure response.

Hermits were said to have begun territorial song in the record-breaking warmth of April 1950, and the first brood had already left the nests at Sandy Beach before my arrival on June 9—possibly a month earlier than emergence in 1948. With this may have been correlated the early migration of thrushes in 1950, which drained off the adults and young of the first brood. Some of the second-brood hermits remained on their territories at Sandy Beach until about September 25.

Thrushes do not show as strong a tendency to migrate in fair weather as do nuthatches (Ball, 1947).

PHOTOPERIODICITY

In reviewing progress (1926–1935) in the study of annual stimuli to migration, Thomson (1936) emphasized the importance of Rowan's (1926) demonstration that in his artificially lighted juncos there is a connection between the state of the gonads and migratory behavior; also that the gonads themselves are affected by seasonal *changes* in the length of daylight—not the absolute length of day.

Moreau (1931), referring to this same classic work of Rowan, writes, "If an internal rhythm is the timing-agent in the transequatorial migrants, it is, of course, not beyond the limits of possibility that it may be confirmed each autumn by the coincidence of diminishing daylight with the retrogression of the birds' gonads. But if this is so, how comes it that the reproductive and migration activities recrudesce six months later, when in the wintering hemisphere, the shortening days are providing the 'wrong' photo-stimulus?" He finds it difficult to believe that the bird's organism can be susceptible to stimulation at one season of the year and not at another.

If, says Moreau, we accept Rowan's hypothesis of internal rhythms that activate southern-wintering individuals of certain races wintering on both sides of the equator, by over-riding external stimuli, we must necessarily credit northern-wintering individuals of the same race with having the same rhythms. Moreau develops this thought with interesting results.

Bissonnette (1937) suggested a resolution of the difficulties of transequatorial migration: "Prolonged refractory periods following maximal activity, with or without environmental stimulation by light or other factors, would supply the necessary delay to prevent even transequatorial migrants from breeding in their southern range. Recovery of the activity phases of the pituitary cycle, even without environmental stimulation at first, will account for the start northward and the reactivation of the sexual apparatus, in various degrees of correlation with each other, depending on the evolutionary history of the species." He further surmised that "inherent rhythms are perhaps more dependent on this regularly recurring refractoriness with temporary regression than upon the occurrence of recurring stimulation."

Rowan (1929) observed that just before and during the southward migration the junco's gonads showed a burst of interstitial cell activity. He regarded this secretory activity as the physiologic stimulus to migration—a positive response. On the other hand Bullough (1945), while agreeing that spring migration of the migratory race of starlings in Britain was a response to testicular and ovarian growth accompanied by increase in gonadal hormones, believed that the fall migration was a response to withdrawal of the same hormones. A similar conception has been expressed by others. Finding difficulty in conceiving how the absence of a hormone can lead to migratory restlessness, one may hope that further experiments will confirm Rowan's observation and conclusions. Further work is necessary in view of Schildmacher's (1933) demonstration that the autumn migration urge of redstarts (*Phoenicurus phoenicurus* L.) can be eliminated by injections of sex hormone; and evidence obtained by Bullough (1942) indicating that lack of southward migration in autumn in the British subspecies of starling is due to partial recrudescence of the gonads. "It seems that the southward urge, which is either induced or allowed by a deficiency of sex hormone, has been overcome by the autumn activity on the part of the anterior pituitary gland . . ." (Bullough, 1943).

Wolfson (1945) declared that the stimulus for migration is not one produced suddenly by momentary or transitory variations in the birds' natural or experimental environment. Rather, the stimulus results from a physiological response (internal factor) to regular changes in day length (external factor) over a long period. The physiological response is shown by increased activity of the pituitary stimulated through the hypothalamus, testis growth, deposition of large amounts of subcutaneous and peritoneal fat, ultimately reaching a state enabling the bird to meet the energy requirements of spring migration (fall migration is not explained). Then the behavior patterns which initiate the migratory flight are released. In an earlier paper (1942) Wolfson conceived the internal stimulus as inducing "the actual migration by releasing the nervous mechanism which controls migratory behavior." Much may be involved in unraveling such a mechanism. One looks to the physiologists and psychologists for the ultimate answer. Already Harris (1944) has suggested that change of habitat (probably for feeding) in the fall may also involve the psychological and physiological changes bound up with migration. That the hypothalamus plays a part was earlier suggested by Benoit (1936) and F. H. A. Marshall (1936).

Were Rowan's observation of autumn gonadal activity repeated in other species, one could with some enthusiasm point out that at this time, following the molt, juncos exhibit increased general activity. Association into flocks proceeds gradually, indicating a change in the attitude of one bird toward another, "playful" chasing occurs more and more frequently. The males often utter short songs, and occasionally reproduce the spring song. Further work would be required in order to determine whether this increased exercise by the birds causes the temporary renewal of gonadal activity, in keeping with Rowan's theory, or whether the interstitial cells function more strongly for some other reason.

Bissonnette (1937), reviewing his work with starlings, emphasized that periods of exercise, with or without added hours of light, inhibited or delayed the effects of light to which the birds were subjected, either concurrently with, or after forced exercise. Since the birds that had undergone the exercise later equaled or exceeded in testis development those which received only added light, he concluded that exercise, although not the stimulus to gonadal recrudescence, as Rowan believed in the case of juncos and similar migrants, nevertheless modified the influence of light as the true stimulus.

Both Rowan (1938) and Bissonnette (1937) find in Benoit's results with ducks support for their interpretations of exercise versus light. While due regard must be given Rowan's contention that not only were Bissonnette's starlings frightened and exhausted by the forced exercise, but even Benoit's duck, although inactivated, was maintained in a wakeful state. Benoit's (1944) later work, together with further experiments by Bissonnette and his co-workers on ferrets and birds, leaves little doubt that changes in the intensity, duration, and quality of light are capable of stimulating increased pituitary, and thereby gonadal activity. In some way spring migration and the completion of the reproductive cycle are influenced by gonadal secretions.

One of the latest contributions to the study of light in relation to the endocrinology of birds is by Bailey (1950). Having demonstrated the inhibition of light-induced gonad increase in white-crowned sparrows (*Zonotrichia leucophrys pugetensis*) by prolactin, he remarks, "The interest lies primarily in the ability of prolactin to exert its influence in the face of a supposedly strong stimulus to the pituitary, namely, light. Bates, Riddle, and Lahr (1937) showed that when follicle stimulating hormone was injected simultaneously with prolactin, the action of the latter was overcome. This is strong evidence that prolactin, in some way, blocks the secretion of gonadotropins by the pituitary. This may be quite similar to the situation existing during the refractory period, for at this time it appears that it is the pituitary which is refractory and not the gonads (Miller, 1948). . . . Only a suggestion of the mechanism for refractoriness is possible at present."

That different species migrate at different periods between July (red-breasted nuthatches, Ball, 1947) and October (last thrushes) is of course well known. It further appears that different individuals of hermit and olive-backed thrushes, or at least the local population in various tributary valleys, such as those of the York River in Gaspé, depart for the south at different times. And the thrushes of Gaspé leave before more northern residents. These observations oblige us to allow great latitude in the range of light intensities at which various birds depart on their migrations. Whether light itself, or some other factor controlled by light, or synchronized with it, is the stimulus still needs clarification. Beach (1949) concludes his chapter on migration with this paragraph:

> No general pattern emerges from the evidence presently available. Much more information obviously is needed before any general conclusions can be formulated. It is not at all certain that the migration of various classes or even of different species within the same class is induced by the same internal or external stimuli. Endocrine secretions undoubtedly are involved, but the extent of their contribution and the nature of their effects cannot be estimated until many careful behavioral and physiologic experiments have been conducted.

To the field observer one of the most attractive facets of the theory that changing intensity and duration of light control migration is its applicability to warm weather movements in summer, inexplicable on the low temperature hypothesis. In Gaspé heavy migration of *Sitta canadensis* occurred on July 23–25, 1941, when the dawn temperatures were 19.5°, 23.5°, and 21.5°C. The maximum flights of six successive years were recorded at temperatures ranging from 8° to 15°C.—all in July and August (Ball, 1947). Many examples among other species could be cited. Soon after the appearance of one of Garner and Allard's pioneer papers (1922) on periodicity in plants, Eifrig (1924) suggested that changes of day length could account for the behavior of juncos, tree sparrows, fox sparrows, and others in the Chicago area during the fall of 1920. Although the temperature remained abnormally high for weeks, and the food supply was ample, these birds arrived from the north as usual, but drifted southward while conditions were still favorable for resting and feeding.

Kendeigh (1934) rejected the theory that light is the all-important environmental factor causing changes in physiology. He proposed that climatological factors, especially temperature, also play an important part. It is significant that E. P. Odum (1949) attributes to low temperature the winter peak in fat deposition by white-throated sparrows (*Zonotrichia albicollis*), and the second, or spring peak preceding migration, to increasing daylight. We therefore have (Wolfson) fat laid down before fall migration after the gonads have regressed and while daylight is decreasing; and (Odum) fat deposition in mid-winter, gonads still regressed, light only beginning to increase, no migration; but in spring, fat deposited while gonads recrudesce as light increases, followed by migration. Bissonnette (1937) agrees with Thomson (1936) that the periodicity is essentially the same in all migratory birds but "may become linked with different factors in the environment according to circumstances. The interrelated reproductive and migration cycles may both be expressions of a periodicity reflecting the influence of all the external conditions governing a bird's life; the phases of these cycles may be induced by environmental stimuli of different kinds, or may occur to some extent without extrinsic stimulus by virtue of an inherent rhythm. In some such way the hypothesis of a primary stimulus from the reproductive system may be given general application to various categories of migratory birds." Bissonnette, however, would substitute for "reproductive system" the words "endocrine system of the anterior pituitary and related glands."

Turning now to the relative seasonal light intensities, for the four years 1947–1950, the numbers of cloudy and fair mornings and days between August 17 and September 2 were as follows:

	Cloudy			*Rain*		*Fair*			*Clear*	
	At dawn	*All day*	*Days cloudy*		*Total cloudy*	*Dawn*	*8 A.M.*$^+$	*Days fair*		*Total days fair*
1947	4	3	3⅓	1	4⅓	6	1	7	6	13
1948	5	2	2½	5	7½	4	3	7	3	10
1949	5	4	4¼	3	7¼	6	1	7	3	10
1950	7	4	4½	3	7½	4	3	7	2	9

It appears that illumination was greatest in 1947 and migration was delayed. In 1950 the greatest diminution of light occurred, and the majority of migrants passed two weeks earlier than in 1947. This is in agreement with the theories of Seebohm (1888), Sharpey-Schäfer (1907), Eckhardt (1909), Thomson (1926), Rowan (1932), Bissonnette (1937), Seibert (1949), and others who have suggested that the autumn shortening of the daylight feeding period and lengthening of the hunger period, either directly or through the endocrine system, may stimulate birds to migrate.

The events of 1949, however, do not fit this photoperiodicity picture so well, for the light intensity was intermediate. Only one cloudy and one rainy day preceded the heavy migration that began two weeks earlier than in 1947. Furthermore, in 1949, at least 32 thrushes left before August 26, the day of first strong movement, whereas only 6 were recorded this early in 1947—none in 1948, another season of intermediate intensity but late migration.

The failure of the 1949 migrants to behave in accordance with this principle of light diminution is emphasized by comparing the shorter periods preceding migration, August 17 to 26. The days were as follows:

	Cloudy	*Rainy*	*Total cloudy*	*Fair*	*Clear*	*Total fair*
1947	3	1	4	2	3	5
1948	2	2	4	4	2	6
1949	2	1	3	6	1	7
1950	2	2	4	4	2	6

In spite of the greatest amount of fair weather in 1949, onset of migration was early.

STIMULI DIRECTING MIGRANTS

Reasoning from the premise that some external or internal stimulus, or combination of stimuli, urges the bird southward, how is the direction of the initial eastward, or even northward flight to be explained? Is the trial and error principle alone operating to bring the bird to a coast that will eventually lead it southward? Griffin (1943) recognizes this sort of behavior in the "homing" of his experimental gulls and gannets. Do adult birds trace again their paths of previous years and thus by tradition guide the young? Or is instinctive racial memory of paths learned originally through trial and error concerned? And is this racial memory supplemented and strengthened by recognition of a course flown the preceding year?

It is difficult to assign a directive environmental stimulus to which a Gaspé thrush, for example, reacts by flying northward instead of southward in the autumn. The true stimulus is neither the intensity nor the incidence of light or of wind, for there is good circumstantial evidence that at the same moment thrushes are moving radially down valleys from the central highlands toward several points of the compass. Unless birds employ personal, racial, or traditional memory to guide them as they leave their summer territories at the inception of migratory flight—in other words, a sense of direction—the stimulus is still to be revealed.

WIND AND NOCTURNAL MIGRANTS

The relation of wind direction to fly-ways and flight-lines of birds is an interesting one. Strong westerly winds of many hours duration drift migrants toward seacoasts and mountains where great concentrations have been recorded (e.g., Allen and Peterson, 1936). Other aspects of the winds' influence are considered below.

Wind has been shown to influence birds at the Break behind Grande Grève and at the Chimney near by where they apparently ascend a rising current through a gap in the cliff. It is of doubtful importance to nocturnal migrants on the rivers and along the bay, for movements there have been recorded only on rather calm nights; diurnal migrants have been most abundant on clear mornings with westerly winds (Ball, 1947). But the birds fly both with and against the wind in the York and St. John valleys; this is particularly apparent on the Forillon where warblers and robins fly southeastward to its tip, then reverse and work back northwestward around the bay. In doing so they have sometimes been observed flying against winds that made progress relative to the ground surface very slow. Nevertheless the air currents seemed to influence their reactions less than the shape of the shore line and the presence of a bay 5 miles or less wide.

Rather equivocal evidence bearing upon the influence of wind upon Gaspé migrants may be drawn from the records of 1940. About 100 migrant olive-backed thrushes were heard at Grande Grève on the morning of

September 12, and an equal number on the next; this constituted the peak for the year. Now, the surface wind blew lightly from the west on the first day, and from the east on the second. The conclusion that these light winds had no appreciable influence is warranted by the figures. But there is the further circumstance that, preceding these flights, a strong southerly gale blew on September 11. Only 4 migrants were heard on this morning, but many olive-backs were recorded on the ground after dawn. One might reason that this gale had driven toward the northeastern Gaspé coast a considerable number of thrushes from the interior, and that these comprised the majority of the high numbers that passed on the two succeeding days. This conclusion is weakened by the lack of hermits; if wind had brought olive-backs, it should have carried hermits as well. Possibly none was ready to migrate; none had yet been recorded.

Another explanation lies in the probability that the storm raised some of the northern Gaspé thrushes to the threshold of migration, which they undertook on these ensuing comparatively calm mornings. That they had not crossed from Anticosti is suggested by the period during which they passed Grande Grève on the 13th. None was heard between 12:00 midnight and 3:30 A.M.; all the 100 birds passed between 4:30 and 5:30. Incidentally, I have no satisfactory explanation of the fact that virtually all migrants flew only down the Forillon on this morning, while those on the 12th (100) and the 14th (50) passed down and back in about equal numbers. Wind was hardly responsible; granting that it was west on the 12th, and east on the 13th and 14th, its very low velocity throughout this period removes it as a probable cause.

In 1941, following two days of light northwest winds, the greatest number of the year passed on the morning of September 16 with moderate wind from the same direction. The two successive peak days of 1947 were in the center of an extended period of calm to light westerly winds. On the only two days of 1947 with strong west winds the number of migrants proved to be much lower than on days of calm to light winds. In 1948 there was one peak on September 8, a morning of light west wind following two similar ones, and a second on September 24, the fourth day of a series of five, all of which were characterized by light winds from the northeast. This September was entirely free of strong surface winds from any direction.

Table 3 presents daily numbers of migrant thrushes and weather data in 1949. Winds of low velocity characterized this season, which therefore provided no demonstration of drifted concentrations. As in previous years most flights were recorded on fair mornings with westerly winds. Important exceptions were September 1, 19, 20, 25; several others passed on calm mornings. While listening to the thrushes behind St. Octave on September 25, consideration was given the possibility that the 196 migrants had ridden the north wind across the St. Lawrence. This source was rejected in favor of the Ste. Anne River valley (p. 105).

Inspection of Table 3 might lead to the conclusion that winds did thus control the paths of migrants in Gaspé, for the majority of movements occurred either with, or immediately after westerly winds. Their low velocity, however, renders this improbable. Moreover, the important exceptions cited above are to be noted. One may point out in addition that nearly equal numbers of thrushes passed on two successive mornings, August 31 and September 1; but the light winds were easterly on one, westerly on the other. One might assume that the westerly winds early in the night of August 31—September 1 had drifted birds into the upper part of the Griffin Cove valley, and that these were recorded descending the valley at dawn against light winds from the east.

Similarly, if wind be a factor, the great (850±) Cascapedia flight of September 19, 1949 (E.–5, cloudy, warm) may be regarded as the aftermath of fresh westerly wind during the clear early morning hours of September 18. But later in the day the wind had shifted to east–3, continuing lightly from east to northeast through the 19th and 20th. On the morning of the 20th (E.–3, cloud, warm, rain later) another heavy movement (550±) occurred. To attempt the derivation of these thrushes from Labrador and Anticosti upon these weak easterly winds would seem unwarranted. The next morning north-northeast winds continued but the temperature was lower (7°C.); at Maria where observations were made only 8 thrushes were recorded.

In addition to this 4-day period the following series of dates offers a contrast as to direction and strength of wind. September 11, calm, clouds moving very slowly from the west, east-southeast at ground surface, fair, 4°C. (first frost of year in low areas), a single migrant thrush was recorded. September 12, calm to light west, fair, 6°C. with frost again on low ground; September 13, light west, clear, 10°C., good movement (225 *Hylocichla*); September 14, calm to light west, cloudy, 9°C. (135 *H.*); September 15, calm to light south, cloudy (showers), 16°C., calm to light south, rain, 14°C. (10 *H.*); September 17, light west, partly cloudy, 8° C. (0 *H.*). Inspection of Table 3 shows that following the 3-day period, August 30—September 1, cited above, migration of thrushes continued for six days of calm to light westerly winds both at ground surface and at the level of clouds when present.

Little support can be found in the above data to confirm the suggestion that these thrushes had been drifted into Gaspé Peninsula by gentle winds.

Nevertheless, in relation to the incidence of migrants from the west and north, an analysis of meteorological conditions during a number of periods especially interesting on account of migratory movements provides evidence admissible in support of an assumption that winds may have been a factor influencing some of them. For example, on August 23, 1949, a good early-season flight passed Sandy Beach, whereas a very weak movement was recorded on the following morning. Since the winds from 2000 to 10,000 feet above the earth were much the same on both mornings (WSW on the 23d and NW on the 24th), but were diametrically opposite to each other at the ground surface (W on the 23d and E on the 24th), one might conclude that on the 23d the westerly surface wind was a factor—not the high level currents. As a matter of fact, however, the force of these surface winds (3 and 4 m.p.h.) was so low as to have little significance. This conclusion is supported by the complete absence of migrants on the third morning (August 25) when strong wind prevailed both at the surface and high above it.

On the other hand, a great flight of 650 thrushes left the mouth of the York Valley on the 26th when the surface wind was west–15, and at high levels, strong, west-northwest–38. If thrushes were actually ushered in on this 2000 to 10,000-foot current, the same force aloft may have been a factor on August 23 as well.

Winds clearly westerly and of considerable strength may possibly have drifted thrushes into the upper Cascapedia Valley in west-central Gaspé, September 19–20, 1949 (p. 85). But why were they not carried farther into the eastern end of the peninsula? One might regard the 850 recorded on the 19th as birds that were, indeed, being borne eastward until the early twilight brought them down into the Cascapedia Valley. Against this idea two contra-indications existed. First, the flight was closely restricted to the course of the river even above its entrance into the channel through the Big Berry Mountains; there was no evidence that the birds had dropped here and there into the broad valley above, to converge on the river at Parson's Pool and Lazy Bogan. In other words, they gave the distinct impression of a well defined and nearly steady current of migrants that had been coursing down the river from a distance—that, like those recorded repeatedly in the eastern Gaspé rivers, they had come from its distant headwaters and tributaries.

The second indication that their presence on the Cascapedia was not primarily the result of westerly winds was that the next morning brought another big flight down Brandy Brook. It is to be noted that at this time my weather data showed weak southeasterly winds at dawn, and Caribou, Maine, reported 10:00 A.M. surface winds east-northeast 7.7 m.p.h., south–14 between 2000–5000 feet, and southwest–26 at 10,000 feet. These 550 thrushes, then, descended a southward-flowing tributary against southerly winds.

Although it appears from data presented in the Appendix that three days of northerly winds might conceivably have aided the 196 hermit thrushes recorded at St. Octave in crossing the St. Lawrence on September 25, 1949, these birds also were probably residents of the Ste. Anne River valley that had just left its mouth and continued westward along the base of the mountains (pp. 81, 105).

Possibly, then, some of these thrushes were drifted into northeastern Gaspé by winds, but all are believed to have been residents of the York and near-by valleys on their first flights of the year. (*See* Appendix for weather maps.)

Thomson (1936) regarded wind as not a determining factor in migration unless strong; birds arrive with winds from every quarter.

Clear or fair (only partially cloudy) sky has been correlated with migration (Ball, 1947). Although not so marked as in the case of *Sitta,* this correspondence is evident in Table 3 on at least 10 mornings' records. On the other hand, six were cloudy, and four of them, August 26, September 19, 20, and 25, were marked by the heaviest movements of the year. On the first of these the wind still blew lightly from the west, on the second lightly from the east, and the following morning was calm; the fourth was calm at the ground surface but the cloud layer still drifted slowly over Ste. Anne des Monts from the north, a direction from which winds had blown (NE and N) for the last two migrantless mornings. Whether movements occurred at Ste. Anne on the following three days is unknown, for I left for Sandy Beach on the 25th. Thereafter no thrushes passed the latter locality before field work ceased on September 28th. The 196 that flew westward along the base of the Shickshock escarpment at St. Octave on the 25th may have constituted the final large group of the year.

It appears, therefore, that in 1949 ten marked flights passed out of Gaspé in fair weather. On the other hand six passed while clouds prevailed, and in at least three instances—two of them especially heavy—while rain still fell. The fronts, though meteorologically "cold," were actually accompanied by warm air at the ground surface. These cases indicate that departures of Gaspésian resident thrushes do not closely follow the "fair *following* cold front" rule that Lowery (1946) found to hold over and about the Gulf of Mexico. In fact, after the two heavy flights down the Cascapedia Valley on September 10 and 20, 1949, during rains following a cool front, the 21st dawned fair. Contrary to expectancy only 8 thrushes passed Maria. Nevertheless it is true that the majority of flights of thrushes, and most of those carried out by other passerines, occur in fair weather.

Winds during the four years 1947–1950 may easily be compared by studying Table 3. First, there is no evidence that thrushes were drifted into the peninsula by them. As would be expected in eastern North America, the prevailing direction was from the west. Before the first strong migrations were recorded, 17 days of westerly winds had passed in 1947, 17 in 1948, but only 10 in 1949. The wind speeds of these days added together give the figures 230, 163, and 83, interesting but not significant; for inspection of the Table shows not a single instance when a fresh wind (20 m.p.h.) was followed by the first flight of the year without the intervention of at least one calm morning. One might concede a drifting influence to the stronger winds of September 13, 1947, and September 18, 1949, had not so many other migration movements occurred while winds were light. Furthermore, at other times fresh winds were unaccompanied by flights. For the sake of the record it may be noted that before the first important migrations occurred in 1947, 1948, and 1949, there had been respectively six, four, and two mornings with winds of 20- to 30-mile strength. Yet migration was extraordinarily early in 1949.

Easterly winds were so infrequent and weak that they may be dismissed from consideration. While it is true, as pointed out above, that September

19 and 20, 1949, were characterized by light east winds, the fresh westerly blow of the 18th would seem of more importance, possibly a factor in the heavy migration down the Cascapedia Valley.

During these years, then, the late summer and autumn winds were normal. The early migrations of 1949 cannot be attributed to periods of air flow from unusual directions, as reported, for example, by McCreary (1934). In that instance the prevailing westerlies of eastern Wyoming were replaced by long sustained easterly winds in the spring of 1933. Migrants that usually travel north through Kansas, Nebraska, and the Dakotas were pushed westward into Colorado, Wyoming, and Montana.

The conviction has been stated above (p. 77) that thrushes in Gaspé fly at heights of not over 500 feet above the ground, not at elevations of several thousand feet as some writers have assumed for many birds, and as a few observers have recorded. At such heights the wind direction usually would be somewhat different, and its force much greater than near the ground.

HORIZONS AS STIMULI

One potential visual stimulus or complex of stimuli acting in common upon all these migrants is the downward trend of their respective valleys. However indistinct the ground surface below may appear to a bird, the sky line is easily discernible on clear nights when migration usually occurs; and this horizon in general slopes from high land at the source toward low land at the coast.

It is simple enough to satisfy N. Tinbergen's (1948) requirement of a configurational releasing pattern, and Thorpe's (1951) extension of the term "releaser" to cover "environmental patterns" such as the appearance of the normal territory, or the kind of landscape which constitutes the normal environment of the species. The horizon is surely a conspicuous component of the landscape seen daily by a bird. When, associated with the unreleased instinct to migrate, the tension already expressed perhaps in restlessness reaches the proper strength the bird sets out down the valley. In the case of adult birds memory of previous experience probably contributes to the general response, for memory of territories is known to persist for at least a year.

A more difficult problem remains. Why should the bird fly northward with a descending horizon rather than southward along an ascending one? The apparent absence of a selective stimulus throws us back for the time being upon an inherited tendency to follow an ancestral path. As yellow warblers and other eastern species in autumn retrace their paths eastward over the British Columbia mountains (Swarth, 1922), or like the arctic tern, these Gaspé thrushes undoubtedly follow courses in some degree instinctive or traditional. Phillips (1951) subscribes to this belief.

It is true that along some valleys one finds in the lower portion a mountain on one bank whose top is higher than some points already passed by the bird. But it may be assumed that the downward course already set directs the birds past such high spots. Furthermore, the opposite horizon may lack such a prominence and therefore may carry on the downward trend. For example, a thrush setting out from the slope south of the westerly flowing portion of the Ste. Anne River would have on the south behind it a steep mountain 2000 feet high (Fig. 21, *A*) from which the horizon drops steadily downstream until cut off by hill B. From the latter the northern horizon across the river rises upstream for a mile or more, but more gently and for a shorter distance. The stream itself probably has little influence unless it is rather wide. It would appear dark, not as a silver ribbon directing the migrant on its way. Furthermore, birds upon reaching a large river may turn either down- or upstream. This occurs at the sharp curve on York River at Whitehouse (p. 75).

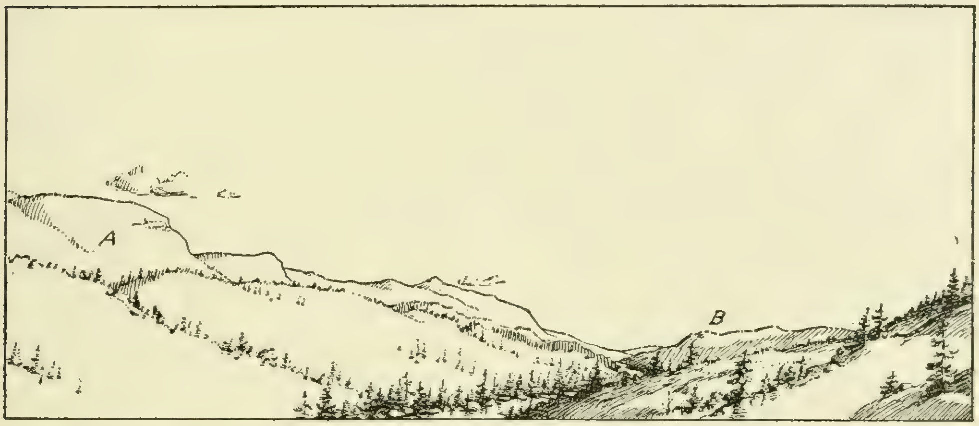


Figure 21. Descending horizon line; view down Ste. Anne River.

This horizon stimulus, then, might act as an effective tool of the trial and error procedure, since all streams lead eventually to the coast.

The valley horizon line should act as a stimulus chiefly to birds that fly at low altitudes; that is, lower than the tops of the ridges that limit a given valley. For these migrants, ridge crests will be most conspicuous when contrasted with the sky. Thrushes, at least during the periods when their call notes are audible, fly at elevations of less than 500 feet above the ground; most of them probably within 300 feet. Calls that can be heard at all, when directly above the listener, are clearly heard. No evidence of nearly inaudible notes overhead has been obtained. Therefore, these birds may be considered as subject to whatever effects the horizon lines may exert.

There are two topographical conditions under which the horizon would be expected to fail as an adequate stimulus to flight in one particular direction—first, a divide, and second, a basin-like widening of a valley, an amphitheater, bordered by mountains nearly equal in height.

Divides and their horizons

In the first case the horizon would descend in two opposite directions, either of which might be followed by birds. An example is the saddle at the summit of the Fox River portage cited above. The majority of thrushes recorded leaving the mountains in this saddle flew southeastward down the Mosher's Brook valley that leads to Gaspé Bay. But several turned northward down the Fox River toward the St. Lawrence.

From the inception of these Gaspé studies the low divide at the south end of Lake Ste. Anne has had an especial attraction. Observations in 1950 and 1951 provided data applicable to this subject of the divide as a part of the horizon. Reference to the lake has been made above (p. 80). It lies in the pass through the Shickshocks made by the Ste. Anne and Little Cascapedia rivers which flow respectively into the St. Lawrence River and the Bay of Chaleur. This pass thus provides a natural pathway across the Gaspé Peninsula for valley migrants.

But the environment of the lake is of special interest in this consideration of horizons because the sky lines on the east and west show little decline, either toward the north or the south. Of possible correlative significance is the fact that thrushes pass both northward and southward.

The narrow lake, 3 miles in length, occupies the center of a 5-mile trough. From the level of its water surface (1294 ft.) the fall toward the north along the headwaters of the Ste. Anne River is only 14 feet in the first half-mile, and 100 feet in the next mile and a half. For the purposes of this discussion the northern end of the trough may be regarded as extending for a mile from the lake through boggy ground that now fills what may have been the bed of Little Lake River before its capture by the Ste. Anne.

From the southern end the land surface rises slowly through boggy ground, occupied by a small pond, to the almost indistinguishable divide. Alcock (1926) writes that a dam only 10 feet high at the present outlet would divert the lake's waters southward into the Little Cascapedia River. Just beyond the divide the small northwestern tributary of that river curves southward from its origin on Mt. Lyall.

A reconnaissance of migrational behavior at this divide and the region about the lake was made possible September 20–22, 1950, by the Parc officials. I was the guest of Mr. Steven MacWhirter, the Superintendent, whom I accompanied into the Parc from New Richmond, and of Mr. Norman Cyr, Guardian of the Game. Two nights and a day were spent at Mr. Cyr's camp situated at the narrows where Camp Brook has brought sediment from Mt. Lyall to push a delta nearly across the lake (Fig. 16). The Parc Service began constructing a group of camps in the summer of that year. These will be rented to fishermen according to the policy of the Ministre de la Peche et de la Chasse. They will be available also to naturalists.

During the late afternoon and evening of the 20th, after arrival at the lake, the only birds recorded were single individuals of winter wren (*Troglodytes h. hiemalis*), song sparrow (*Melospiza melodia*), rusty blackbird

(*Euphagus carolinus*), horned owl (*Bubo virginianus*), and kingfisher (*Megaceryle alcyon*). No calls of thrushes were heard.

At 4:30 next morning, although heavy frost had whitened the ground and one-quarter inch of ice covered the water in the pail on the porch of the camp, the sky had become overcast. The air was calm except for intermittent westerly breezes. *Bubo* resumed his hooting at 4:45, but it was not till 5:12 (0.0006 f.c.) that the first olive-backed thrush piped. Others followed at 5:12.10, 5:13, 5:14, 5:15–5:17 (6 hermits ?), 5:19, 5:25, 5:29 (5), 5:33 (2), 5:37 (3), 5:38 (3)—a total of 25 birds.

The extraordinary aspects of their behavior are that all of them flew northward away from the divide, and that most of them apparently rose from an area of some four acres from which the forest had been cut years earlier. This was done when the Park Service constructed the road from the Federal Mines on the North Branch of Berry Mountain Brook to Lake Madeleine. This clearing extends from the lake in the vicinity of Cyr's Camp (Fig. 16), to the edge of the uncut forest 150 yards up the gentle lower slope of Mt. Lyall. It supports a mixed growth of young conifers, birches pin cherries, and weeds.

Only 3 thrushes called at points over the forest outside this area. One of these (5:14) uttered a single note on the east side of the lake at the foot of Mt. Sterling. Here the old road was being overgrown with bushes, providing cover similar to that in the clearing. The other 2 birds (5:38) piped strongly in the dense conifers behind the camp 50 feet south of the forest margin. They were the last to depart, their tardiness probably to be explained by the darkness of their resting place.

That these 25 thrushes were actually starting their flight from this area during the morning twilight seems probable first, from the fact that none was heard approaching from the south along the lake shore nor the slope above it—and such notes could readily have been detected; second, from their clearly audible flight northward down the lake; third, from the lack of customary ground calls in the vicinity. Had we been dealing with birds that had begun flight beyond audibility southward, perhaps on the slope of Mt. Lyall's southeast peak, some of those last thrushes heard as the light intensity increased to the critical value (0.02 f.c.) should have been descending to feed in the clearing. But careful search after dawn failed to disclose any evidence of thrushes.

It is known that migrants occupy feeding areas for variable periods. One may imagine, but cannot prove, that these thrushes had settled here on a previous morning to rest and feed. On the other hand their departure described above may have been the initial step of the series that led toward their wintering grounds in South America.

The field evidence did not support the hypothesis that they were in flight from some locality south of the lake beyond the divide, and were first stimulated to call here at the clearing. And yet a consideration of the topography and environment of the region of which the lake is the center, together with a background of the behavior of migrant thrushes, renders this hypothesis a reasonable one. Indeed it had been expected that evidence of flights both south and north would be obtained here. Additional observations made in 1951 suggest that reflections of horizon and of the moon stimulate migrants. Further study is contemplated on these phases of the problem.

Four questions deserve answers. 1). Do all thrushes resident between the lake and the confluence of the Ste. Anne River and its northeast branch, 12 miles below, migrate northward? It will be recalled that field work in the region between this branch and the St. Lawrence during 1947 and 1948 had established strong flights northward (downstream) and weaker ones upstream toward the lake (p. 80). But 1949 studies in the next valley, the west branch of Berry Mountain Brook, and on Brandy Brook beyond, as well as along the Cascapedia into which they run, uncovered no trace of northbound migrants; the topography there does not favor such a course. As yet no observations have been made between Lake Ste. Anne and the mouth of the Northeast Branch. 2). Do all thrushes resident south of the lake fly southward along the Little Cascapedia? 3). Do any residents from about the north end fly south, and from the south end north, past the lake and away from the low divide? 4). What is the behavior of residents of the forested slopes above the lake?

Although no answer to question 2 based on observations along the Little Cascapedia can yet be given, there is reason to suppose that all migrants there pass downstream as elsewhere in the peninsula. Studies in September 1951 at the south end of the lake revealed in early dawn only southward migration by 65 olive-backed thrushes that in small groups had already passed up the lake from the north. In addition, as the light intensity induced descent to the ground, several gray-cheeked (probably Bicknell's) thrushes were traced to and fro above the swamp, before commencing to feed. Two or three rose to the flank of Mt. Lyall. I could hear none passing toward the low divide as though to enter the valley of the Little Cascapedia. As explained on page 127, these gray-cheeked thrushes had doubtless descended from near-by mountains.

To question 3 only negative evidence has thus far been given in the section above relating the story of northward flight from Cyr's Camp on September 21, 1950. Attention should be called to the location of this camp in the clearing described. More than a half-mile from the outlet, it lies on the northern border of the delta that, according to Alcock, has been built out into the lake from debris carried from the slopes of Mt. Lyall by Camp Brook.

The morning of September 22 again yielded no positive evidence of thrushes moving southward "up" the lake. When I left camp at 4:30 the sky was partly cloudy, the wind southwest 0–3 m.p.h., and the ground and vegetation crisp with frost. Puddles of standing water left by the rain and melting snow that had fallen on the previous afternoon were again covered with ice. Hoar frost covered the oars and thwarts of the boat in which I rowed up the lake.

Not a bird call was heard beside or above the lake during the hour required to reach the south end. This disappointment was only in part removed by events along the boggy inlet from the pond south of the lake. Here at 5:38 a single note was uttered just above the treetops, supposedly by an olive-back. The light intensity had then increased to 0.05 f.c. Twelve minutes later came an outburst of harsh, vibrant calls from an area 200 feet distant, just east of the spruce-dotted bog. Here young conifers clothe a small wind-fall at the base of a nameless mountain that flanks the south end of Lake Ste. Anne and terminates in the divide. These were the notes of 5 or 6 gray-cheeked thrushes, unfortunately indeterminable as to subspecies. For, so dense grew the 6- to 10-foot firs and spruces among the prostrate decaying remains of fallen trees, that by the time the barrier had been penetrated the birds had become quiet and remained hidden.

Two considerations lead to the assumption that this was a group of Bicknell's thrushes that had descended by way of Bois Brook from Mt. Sterling, timber-line being at an elevation of about 2800 feet, and had failed to cross the divide before dawn. First, the loudness and rapidity with which the calls were given is typical of thrushes that have just ended their flight and immediately voice, as it were, their appreciation of the new environment—possibly of the prospect of food. Secondly, no calls of *H. minima* had been heard about the north end of the lake on the preceding morning. Furthermore, it should be recalled that on September 20, 1949, a considerable proportion of the hundreds of thrushes heard passing down the near-by Brandy Brook valley represented one or the other subspecies of gray-cheek.

For question number 4 concerning residents of near-by slopes, we have first, the data derived from the Cyr's Camp area in 1950, and outlined above (p. 126). Second, the results obtained in 1951 during a 9-day period, September 10–18, cannot be regarded as reversing those of 1950, for an even greater number, 79 olive-backs, were heard passing northward over Cyr's Camp and the outlet of the lake—again away from the divide. Nevertheless in 1951 a total of 674 thrushes flew southward past the lake, but they represent, not a new phenomenon, but the migrants that normally, it is believed, use this avenue to reach the south coast of the peninsula. Of the 79 migrants mentioned above, 75 moved northward on September 11, eleven days earlier than those recorded in 1950. One may tentatively conclude that migration in general was earlier this year, and further that the 74 thrushes that left on the 11th represented the local population from about Cyr's Camp clearing. It would be quite in accordance with the rule that more southern residents of a species depart sooner than more northern ones. It must be admitted that the latter passed south too soon to fit the rule, unless their summer territories lay not far distant—perhaps in the Ste. Anne River valley.

The four birds that left on the evening of the 12th may well have been residents of the slope of Mt. Lyall's southeastern prominence, departing northward away from the divide.

That the 1951 season was actually earlier is, of course, not proved by this behavior of northbound thrushes. One does not know whether in 1950 the great southward movement through the pass occurred between the 12th and 17th as in 1951, or in the week following the 22d. From experience in other years one would predict major flights, on the average, not later than September 20. A longer observation period during this month is required to disclose satisfactorily the behavior of thrushes resident about Lake Ste. Anne.

One can regard these 1950 and 1951 visits to Lake Ste. Anne as little more than a reconnaissance. It is planned to study the early summer nesting population there, and to record migration over sufficient periods in autumn to permit more satisfactory conclusions to be drawn concerning migratory behavior in this interesting region.

This trough, and the low divide at its south end then, constitute a natural testing ground in which to observe the behavior, first, of migrants crossing the peninsula, and second, of residents at the inception of their migratory journey. The trough is sufficiently long, and the environment so similar at the two ends, that one may expect to record informative responses by both residents and transients. "Mistakes" may be made in directing some of them into unusual channels.

If this be true, it is conceivable that in starting upon their journey they might face the wind then blowing. What should have been the course taken by these thrushes at Lake Ste. Anne? If they had "taken off" into the light southwest wind they would have passed up the slope of Mt. Lyall. But actually they flew nearly in the opposite direction. In trying to reconcile this behavior with the contrary-wind theory one might reason that the 3-mile breeze was not strong enough to influence the thrushes. At any rate one may safely conclude that this southwesterly wind, blowing across the valley rather than through it, could not have been the force that directed them northward. Instead, according to the theory of moderately adverse winds, they should instead have flown up the lake, that is, to the southward. Probably the wind on this morning exerted no influence upon the birds. It may be recalled that passerine migrants up and down the Forillon were often observed flying both with and against winds of various strengths. Such studies may answer, among others, the following questions: Are traditional paths important here? Do unusual meteorological conditions alter their responses to topographical features? For example, do northerly winds draw birds northward according to the view held by some observers, that opposing winds if not too strong favor migrations (Raines, 1950)?

A thought that recurs is the "bird's-eye" view, in other words, the horizons available to migrants leaving the clearing at Cyr's Camp. To the few birds that rose above the surrounding treetops both ends of the trough occupied by the lake were visible. The northern outlet as far as Mt. Albert, 9 miles distant, was perfectly evident even to a man standing on the ground (Fig. 22, *A*). Between the high western and eastern mountains, culminating respectively in Mt. Albert and a nameless summit southeast of Hogsback, the view toward the north is divided into three vistas by Hogsback and Little Hogsback. The western and middle ones appeared to me equally attractive as avenues leading toward the St. Lawrence. Owing to interlocking mountain spurs the view northward showed a high sky horizon above the Ste. Anne River.

In the opposite direction birds that might rise 30 feet above the camp roof would have an unobstructed view southwestward across the divide into the valley of the Little Cascapedia (Fig. 22, *B*).

To a bird responsive chiefly to visual stimuli, and seeking an open path, the southward one should have been more acceptable, not because of descending horizons, but on account of a lower distant sky line seen through a wider outlet than was apparent beyond the opposite northern end of the lake.

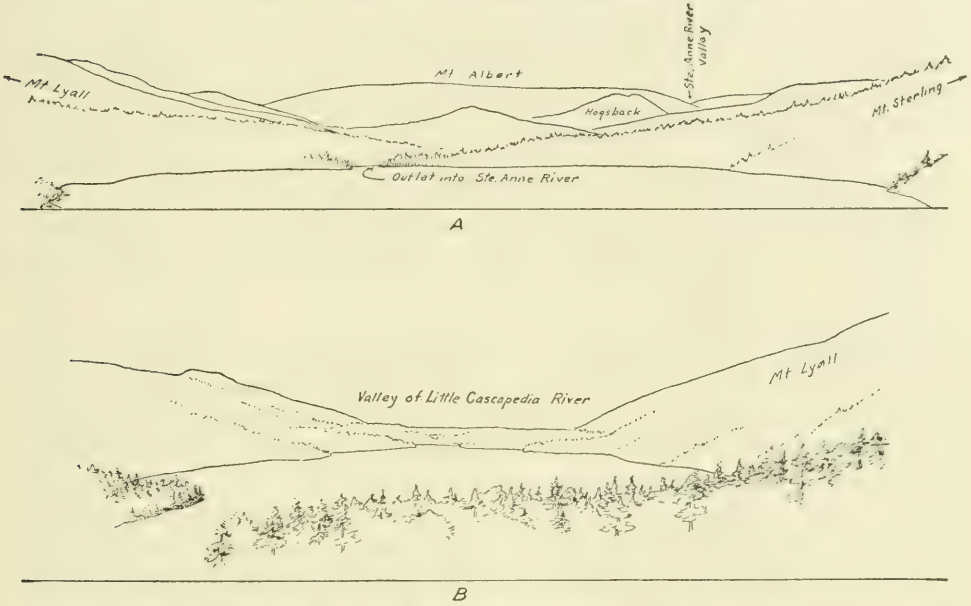


Figure 22. *A*. View north from Lake Ste. Anne showing horizon toward which thrushes flew down Ste. Anne Valley from Cyr's Camp at dawn. Hogsback and other intermediate hills were barely visible. *B*. View south over lake and low divide into valley of Little Cascapedia beyond, as seen by birds that rose above trees at Cyr's Camp. This view would appear unobstructed and therefore be more favorable than *A*.

However, of the 26 thrushes that left the clearing about Cyr's Camp on September 21, few, if any, rose high enough to have seen the southern gap; their view was screened by the uncut forest that descended upon the delta from Mt. Lyall. Once launched, the majority of them were traced down the Ste. Anne Valley until their calls became inaudible. It must be conceded that those which emitted only a few notes may have turned back silently after reaching an elevation that disclosed the southward pass.

The calls of their mates, however, probably contributed to the maintenance of their initial course.

In 1951 the nine days spent at Lake Ste. Anne provided few data with regard to the influence of horizons. But records of the numbers and courses, and origin of migrants through this pass, added to those of 1950, permit us to summarize matters as follows.

While thrushes were flying northward at Cyr's Camp near the north end of the lake none was heard simultaneously passing southward. Studies thus far made at the south have not detected residents departing from that area, though many have been recorded passing above it from the north. One, of course, expects the residents here to orient southward over the low divide into the Little Cascapedia Valley. The southbound transients doubtless, by example, would encourage such behavior; on the other hand, they would not favor a northward orientation. Hence the above observed occurrence of the latter movements, may never take place during pronounced southward flights out of the Ste. Anne River valley.

Thus far no evidence has been obtained that wind or other meteorological factors are concerned. Further data are needed to elucidate migrational behavior here. Again, at least temporary recourse to tradition and inheritance may be admissible.

Making concession to tradition, some of the "descenders" of the Ste. Anne may be expected occasionally to establish nesting territories along the lake among those which continue to follow the path of their ancestors down the Little Cascapedia. If tradition then remains strong, members of the two stocks may begin migration in opposite directions.

Thus far we have regarded these thrushes as starting their migratory flight from the Cyr's Camp area. Let us assume, instead, that they had flown northward down the lake, possibly from beyond the divide, or from the west over a high saddle on Mt. Lyall. Since their first calls were heard at 5:12, after morning twilight had begun, they may have been in flight since the previous evening. This long period would preclude their having come from the southern part of the peninsula via the Little Cascapedia Valley, or even up Berry Mountain Brook from far to the southwest. But if they had ascended from the St. Lawrence shore or lowlands through the pass in which lie Lakes Thibault and Coté west of Mt. Albert, or possibly by way of the Ste. Anne River and its western tributary, Isabelle Brook, they may have crossed the dissected tableland west of Mt. Lyall and then crossed the high saddle between the southern and middle peaks of this mountain. From that point they could have been influenced by the same conditions that would operate upon resident birds setting out from the southeast shoulder of Mt. Lyall; that is, the northern horizon may have attracted them more strongly in the intensifying light of dawn.

The assumption with which we have just experimented has led to an unsatisfactory conclusion, for the topography on the west of Mt. Lyall is not likely to direct nocturnal migrants over this pass; they should have descended southward either along the northwest branch of Berry Mountain Brook, or along Brandy Brook as witnessed in 1949. The only alternative remaining is that the birds dropped down at dawn from a higher level, perhaps attracted by the lake with its marginal feeding grounds. But having found this hypothesis unsatisfactory (p. 177) we accept the origin from the clearing.

One note heard among the early migrants (5:14) at the foot of Mt. Sterling may possibly have been uttered by a thrush that had flown northward along the east shore, instead of departing from forest-edge bordering the Mt. Sterling road as surmised above. Similarly the 2 birds that piped at 5:33 high up Mt. Lyall's flank may have come northward along the slope, having risen somewhat earlier at a point, say, on the northern aspect of its eastern peak. From here the southern outlet down the Little Cascapedia would have been hidden.

One may have recourse to one of the later night periods of migratory restlessness (cf. Palmgren, 1944) in order to account for the presence of these thrushes heard at Cyr's Camp. If one assumes their departure at a light intensity that stimulates thrushes to begin evening flights, the morning departure may have taken place at dawn, as first interpreted, from the area near camp; or a few minutes earlier from some location on Mt. Sterling. The 5:14 bird might be regarded as having descended Bois Brook, in which case its view down the Little Cascapedia would have been obstructed by the unnamed mountain opposite the southeastern mass of Mt. Lyall; it chose to fly north along the base of Mt. Sterling.

This question of the starting period is, of course (cf. p. 67), to be considered together with the distance flown before dawn stimulates the birds to descend to the ground. I see no escape from the conclusion that on a given night some individuals travel much shorter distances than others. The longest journey would be possible for birds setting forth in the evening—about 7:30 at this season. In 10 hours of flight (7:30 P.M.—5:30 A.M.) at 25 m.p.h., 250 miles could be covered. As we have seen, not all of this would be southward; thrushes starting from Madeleine Fork on the York River at 7:50 P.M., like all their kind, flew eastward down the valley. Without doubt they eventually reached the Bay of Chaleur and continued along the shore.

The query now arising as to whether these birds were likely to travel all night, reference is made to the power of nocturnal vision in birds (p. 65).

Amphitheaters and their horizons

Of the second sort of topographical feature whose horizon might be expected to confuse migrants (p. 123), an example exists on the York River between "No. 17" and Mississippi Brook. Here the floor of the valley widens to a half-mile and is comparatively flat for a distance of 3 miles. To an observer, the surrounding horizon is rather characterless. Without a view of the river's current, and lacking knowledge of the country, he would be unable to judge from which end of the amphitheater the stream would flow. Actually, except in one instance, such thrushes as have been heard in this section were headed down the valley. Most of them, of course, had already set their direction from farther up the York Valley. But it is difficult to understand how a bird emerging into this section from one of the tributary valleys high on the north slope could detect enough change in the opposite horizon to stimulate it to turn left down the valley. Yet a bird's vision is keen, possibly enabling it to distinguish, and react to, a slight decline. Furthermore, this decline may appear greater to a migrant 200 or more feet above the floor of the valley than to an observer on the ground.

The exception mentioned above helps to prove the rule. On September 4, 1949, between 4:25 and 5:01 A.M., at least 130 olive-backs and hermits flew eastward down the York Valley at the foot of 28-Mile Hill. This marks the western entrance to the amphitheater now under consideration. The striking exception was furnished at 4:42 by 3 olive-backs that obliquely crossed the paths of the other migrants. They flew directly and noisily on a west-southwest line past the foot of the hill toward the entrance of the York River. That they had entered the huge amphitheater through the deep notch in its northern wall, carved by the east branch of Mississippi Brook (Pl. 1, *C*), was strongly suggested by their line of flight, and by an episode that occurred on October 7, 1941. Soon after dawn on that day some 300 robins were seen to emerge from this notch and, like these 3 thrushes, to turn westward. It was surmised at that time that they either saw in the distance, or knew from experience, that extensive blueberry burns lay in that quarter. Possibly these robins, as well as the thrushes, found the horizon line in this part of the valley non-directive.

It should be emphasized that the gulch in question is directed squarely toward the river, not obliquely downstream like most tributaries (Fig. 2). Birds flying through it would not have their course set down the valley. In other words they would be equally subject to any influence to turn right or left. To the human eye from a point low in the throat of this notch the westward avenue upstream beyond 28-Mile Hill appears less obstructed than the river's exit at the eastern end of the amphitheater.

For example, on September 19, 1950, an ascent of this east branch of Mississippi Brook, known as Brook 35, was made. Leaving the main road at 4:40 A.M., I followed a trail partially overgrown with bushes and young trees. Heavy clouds driven by a 15- to 20-mile wind delivered intermittent showers from 4:58 to 5:45. Nevertheless at 5:12, when I had reached a point high in the throat of this narrow valley, the first 5 olive-backs passed down, piping steadily just above the treetops. Here was a much desired opportunity to observe their behavior as they entered the wide York Valley, for rain had temporarily ceased. Without hesitation the group swung to the left (eastward) along the flank of the mountain. Their receding notes left little doubt that they were to continue down the York.

Two other groups, 3 birds at 5:15 A.M. and 10 at 5:22, passed me as I climbed higher—too far from the main valley to determine which direction they were to follow. The first ground note was heard at 5:27 (light intensity 0.003 f.c.) and by 5:52, when I turned back near the top of the divide, 16 others had been located. They were about equally distributed on both banks of the stream. One hermit taken proved to be a juvenile still in the molt. Possibly it was a resident. Others, however, were very evidently working slowly down this tributary valley. From one such group a juvenile olive-back was collected at the end of a 150-foot advance from tree to tree.

An outlook across the York Valley was provided by a small cleared area well up in the pass. Although only a short extent of the southern horizon was visible from the ground, a much more extensive view was, of course, open to birds flying above the trees. The outline of the hills was probably not very different from that presented in Figure 23 drawn from the floor of the York Valley. Both these views showed an horizon descending toward the east, the direction followed by all but a few exceptional dawn migrants recorded during years of study.

Although streams such as the York River, even on a clear night with a maximum of light from sky and moon, may not be sufficiently visible to enable migrating birds to detect the direction of flow, the sound of the water rushing over riffles, rapids, and falls may be audible to them. This could supplement the horizon lines and dimly illuminated slopes in marking the course of the valley; it could not, like the horizon, serve as a directive, unless one endows the bird with the capability of observing the gradual increase in width—and this is by no means uniform in rate throughout the length of the York. Furthermore, thrushes in a dichotomy freely pass both down- and upstream from the vicinity of Whitehouse (p. 75).

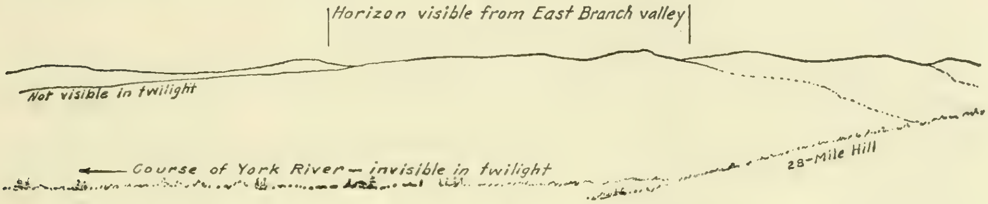

Horizon visible from East Branch valley
Not visible in twilight
28-Mile Hill
Course of York River — invisible in twilight

Figure 23. Southern horizon of York Valley opposite Mississippi Notch.

The auditory sense should prove especially helpful along the coast; for the noise of surf, though variable in strength, is rather continuous. Doubtless the birds' visual acuity (p. 65) enables them easily to detect the shore on all except the darkest nights. The auditory sense may be important in times of low visibility.

It has been stated that hundreds of robins were seen on two mornings entering the York Valley through the two or three passes worn by tributaries of Mississippi Brook, and many of them worked up the York through blueberry clearings that were visible in the forest. But we have also found robins many miles eastward ascending the valley where blueberries were lacking; and again farther west near First Bridge, September 24, 1941, a flock left the blueberry grounds to cross the river to the top of a densely forested slope. Since the river here was flowing southward the robins were flying west across a great meander, in a direction that would shorten the distance to extensive blueberry "burns" at the headwaters of the St. John and Bonaventure systems.

Data have been presented to show that diurnally robins and warblers not only descend the York and St. John rivers to follow the coast southeast, but also ascend them from the bay. Although this movement is strongest during the first two or three hours after dawn when the birds are the hungriest, it can hardly be imagined that feeding grounds 50 miles westward up the stream can be the incentive; plenty of food is available along the coastal forest margins and fields. Moreover, unless two different populations with innate tendencies to follow opposed flight paths are concerned, why do some birds work upstream while others of the same species pass down? It seems more probable that here also, in searching for a way southward, the trial and error principle accounts for their behavior. Having turned inland at the mouth of an estuary, in accordance with their propensity to follow the shore, some fail to cross at its upper end, but continue inland along the river bank and the slope above it.

In other words, the number and summative intensity of factors affecting a diurnal migrant may be greater than at night; the horizon line may act more strongly upon nocturnal migrants, while the river margin, combined with search for food, acts more strongly by day. Palmgren (1936) has expressed the opinion that in daylight more or less involuntary reactions to the environment, especially in feeding, dominate over internal stimuli to migration. It may be added that they probably also dominate other external stimuli.

SUNLIGHT AND MOONLIGHT AS DIRECTIVE STIMULI

Sunlit trees and slopes have been cited above as attractants of birds. Other impressive incidents could be described in which individuals suddenly swerved from another course and with accelerated speed rushed directly toward the sun itself. If we consider light as a visual stimulus to migration in Gaspé, we must note that during the evening twilight (civil to astronomical) the western skylight is more intense than elsewhere. Yet all thrushes found migrating at that time passed eastward along the York and St. John. Before dawn their direction was the same, although the eastern sky was then brightest. During the midnight hours when the sky had a lower and uniform intensity their flight was still eastward.

The following instance may be presented as evidence that increasing intensity of dawn light stimulates migrant thrushes to alter their course. At 4:18 A.M., August 26, 1949, I stopped beside the Sunnybank-Wakeham bridge across the York River half a mile above its mouth. Having frequently paused on my way up the estuary to listen, without hearing a note, I felt confident that within the next few moments I was to record the first one of the morning. It came immediately, at 4:19, the high abrupt pipe of an olive-back. Two and a half minutes later (4:21.30) the second thrush called from directly overhead. The notes were repeated at 5-second intervals as the bird passed down the south side of the valley. At 4:24, 2 more birds followed the same course.

Thus early, although the sky was clear, a flashlight was necessary even to see where to write in the field-book. Not until 4:44 (0.005 f.c.) was I able to discern the last penciled entry without the aid of the light. By 5:00 o'clock most words were legible (0.02 f.c.).

After 4:25 A.M. migrants passed continually and increased in numbers. The climax was attained between 4:46 and 4:48 when an estimated 115 birds were recorded. The numbers then decreased until 4:56 when the last thrush was heard in flight. Thereafter some 25 olive-backs uttered their ground notes among low trees and shrubs along the river bank.

Now the aspect of this movement that is pertinent to our consideration of light as a stimulus is the paths followed by these 642 birds. The first 15 passed down the south side of the valley—some 200 yards distant from my station. Then at 4:34 one call was heard on the north. Two more followed there at 4:37, while 3 were passing overhead and 15 on the south.

Preponderance now shifted to the north lane, as shown in the approximate distribution below:

	South side	*Center of valley*	*North side*
4:37–4:40	15	3	10
4:40–4:43	15	10	25
4:43–4:45	20	20	40
4:45–4:46	30	20	50
4:46–4:48	15	30	70
4:48–4:50	12	18	60
4:50–4:52	—	25	50
4:52–4:54	—	10	40
4:54–4:55	—	6 (1 on ground)	14
4:56	—	25 on ground	—

It is possible that during the height of the movement, when the air seemed crowded with thrushes, a few calls from the south passed undetected. However, the shift from the south to the north side of the valley was very definite. It was ascribed to the increasing intensity of light in the sky ahead over the shoulder of the Wakeham hills. Naturally this glow was directly above the point where the sun was to rise.

Although at 4:20 A.M. the sky had been clear, cirro-stratus clouds began moving in from the west at 4:30, and by 4:50 denser clouds had obscured much of the sky except far in the east, thus intensifying the light in this area toward which the birds were flying. The first faint pinkness of sunrise tinted the under surface of the easternmost fragments at 4:56, and the thrushes descended to the ground during the next few minutes in a tableau of strengthening color.

On the following morning I witnessed a strikingly similar performance farther up the York Valley where Big Fork Brook enters the river from the north. In addition, another response to light was shown by 6 or 8 hermit thrushes that descended into young poplars beside the road. The brighter surface of the latter evidently attracted them, for none was heard at a distance of more than 20 feet from it, and furthermore several of these birds flitted back and forth across, as well as along the road. As noted elsewhere, this behavior is also shown by sparrows, juncos, and other small birds at dawn. Crepuscular nighthawks frequent these forest roads and, rather than forsake the conspicuous path, dart up before an automobile's approaching headlights, only to alight again farther on, and so to repeat the reaction.

An opportunity to observe the response of thrushes to dawn light while a brilliant full moon hung high in the opposite sky was presented on September 7, 1949. At the summit of the Fox River portage, as I faced northwest, the moon was about 10 diameters above a hill on the west at 4:21 A.M. Dawn was barely evident beyond the saddle on my right hand, somewhat north of east. As nearly as I could judge by masking the moon with my finger the sky about it at this time was of an intensity barely less than the eastern sky. Thrushes passed southwest down Mosher's Brook (Fig. 10) toward Gaspé Bay at 4:26, 4:28, 4:30, 4:47, and 4:48. The first smoky light appeared in the east at 4:44.

The eastern light had increased noticeably by 4:52, and interestingly enough 5 thrushes then crossed the road and passed northeast through the saddle and toward the dawnlit sky that was exposed to view between the mountains. They were followed by 10 others between 4:55 and 4:59. Meanwhile the moon had nearly sunk behind the western hill. Its disk was certainly still much brighter than the eastern sky, but the area about it seemed darker than at 4:21.

Therefore one may safely conclude that these birds, if truly influenced by light intensity, reacted not to the moon's orb, but to a relatively brighter diffuse eastern sky as compared with the western area *about* the moon. That birds do not fly toward the moon itself is evident enough on any night when it is visible and when migrants are in flight.

It remains to test the possible attractiveness of a full moon's glow from behind the eastern horizon. Although a response to this can scarcely be expected, the tendency of migrants to travel, or at least to be more vocal on nights with strong moonlight, is well known. For example, on the evening of September 4, 1949, the moon, nearly full, appeared to move westward above the hill south of Sandy Beach. At 7:42 thrushes began passing, not over this hill but eastward along the shore, with the moon on their right. Continuing in small numbers till 8:20, no more were heard during the listening period ending at 10:25. Beginning again at 12:25 no birds were detected until 12:34. One thrush was followed by other single migrants at 12:36, 12:41, 12:47, and 12:52. Clouds obscured the moon from 12:50 to 1:09, when it emerged considerably veiled; no migrants had appeared up to 1:14 when I left the station. At 1:35 the moon had dropped so low beyond this hill that the slope was in shadow. Only a narrow border along the shore still received its direct light. A single thrush followed the usual route along shore at 1:36. No more were heard in the next 10 minutes, nor were birds vocal during a quarter hour's vigil begun at 2:25 A.M. At 4:00 the moon in the far west had again become obscured. Hearing no birds I left for the St. John River at 4:06 (Sept. 5). Still no thrushes were seen until a weak dawn movement down valley began at 4:50. The light intensity was now 0.002 f.c.

During the night just outlined the distribution of migrants was not unlike the pattern recorded on other fair weather nights lacking moonlight. The fact that no call notes were detected in the period between the moon's obscurance and dawn, taken together with their virtual absence during the night hours when the moon was clouded, may tentatively be regarded as evidence that these migrants, under the stimulus of moonlight, similar in intensity to that of the evening and morning twilight, were setting out from their summer range in the valleys leading to Gaspé Bay.

Since migrants at the mouth of the York, at Big Fork, and at the top of the Fox River portage had apparently been attracted by eastern dawn light, the thought occurs that their migration down all valleys with an easterly trend may be ascribed to this stimulus. But at once this proves inadequate to explain their flight down the opposite (southwest) drainage from the Fox River pass to Gaspé Bay, as well as from the Ste. Anne, Cascapedia, and Matapedia valleys. Nevertheless, the evidence presented above points to the strengthening dawn light as the stimulus that caused the above-mentioned 15 thrushes at the divide to turn northeast down the Fox River instead of southwest to Gaspé Bay as do the majority of migrants here.

After dawn, skylight is strongest in the east, but migrants pass both east and west in the above-mentioned valleys. One might resort to the interpretation that some of these birds are attracted eastward by the brighter sky, and others westward by hills whose eastern slopes are sunlit while their western slopes are shaded.

Data concerning diurnal migrants gathered from valleys leading north or south are as yet insufficient to afford much help in assessing the influence of light. The evidence at hand from the relatively small valleys of the northward-flowing Fox and Griffin Cove streams consists chiefly of warblers after sunrise crossing westward from the shaded to the sunlit slopes. This direction is opposed to that expected of migrants on this southeasterly trending coast.

Unfortunately both mornings spent on the Cascapedia in 1949 were cloudy, thus affording no opportunities for observing the influence of eastern light on southward-flying migrants. Even on a clear morning there could have been no effect at Station 2 on Brandy Brook; steep hills on both east and west allowed only the sky overhead to be seen. If possible at any place, the station at Lazy Bogan, occupied September 19 as described, should give a fair test on a clear morning, for thrushes passing down the Cascapedia there would already be directed southeastward by the river itself (Fig. 2). More important to the present discussion, they would have a view east and northeast up the Berry Mountain Brook valley and might thus at least be exposed to the more intense dawn light. However, it seems improbable that migrants would there be drawn eastward away from the large stream.

Instances of individual warblers, robins, and other birds veering toward the sun were given in my nuthatch paper (Ball, 1947). Many similar cases have since come to my attention.

Orientation to sunlight in one-direction navigation by homing pigeons and migrating wild birds was regarded as plausible by Matthews (1951). Experimentally, Kramer (1950) in autumn found distinct southward orientation by caged *Sylvia atricapilla* and *S. communis* when placed in an open field.

LENGTH OF FLIGHT BY THRUSHES

We may raise again the question of how long a thrush leaving the ground at dusk remains in the air. Does it, 1) fly all night, vocal during the evening hours and just before dawn, silent during the other hours or at such elevations as to become inaudible, or 2) fly only at moderate audible heights, descend to rest quietly for a time, and set out again not long before dawn, uttering the notes that are so characteristic during that hour? If flight calls are to be regarded as associative signals between members of a migrating species, one would expect them to be sounded continually during flight. The second alternative above would then satisfy the recorded frequency; the few calls heard between midnight and 3:30 A.M. could be attributed to exceptional migrants that began their flights later in the night.

Another interpretation of the function and timing of these notes is possible. Early in the evening when the first migratory calls are heard they are louder and more frequently uttered than is true an hour or two later. This may be attributed to the excitement of departure. Again, at the approach of dawn the number and frequency of notes heard is especially striking, and may signify excitement induced by the increasing light, or even enthusiastic anticipation of the descent and of the ensuing period of rest and feeding. That the latter is very real cannot be doubted by anyone who has heard a group of hermits and olive-backs descending all about him. The pipes, *quees*, and *chucks* are fairly ecstatic for a few moments, accompanied by dashing and chasing among the barely visible trees and bushes. Diurnal migrants also are likely to call only at the points of departure and arrival. This has been noted in the case of red-breasted nuthatches (Ball, 1947). Under this interpretation the first alternative suggested above, all night flight, could apply. This would account for the lack of increased calls at times during the night that might be expected were groups of migrants to descend at odd hours.

It has been generally assumed that birds migrating on dark nights would have difficulty in landing. This is undoubtedly in some degree true. It is also probable that few small birds begin their migration on really dark nights; hence their need of landings within the darkened region of origin is infrequent. It must be borne in mind, however, that birds may begin their flight in one locality under open sky, but encounter adverse meteorological conditions that cause them to descend in another region.

When such descent must be made under severe meteorological conditions—heavy precipitation, high wind velocity—catastrophe overtakes the birds. Due to their inability to see well enough to land with precision, collisions with obstacles become frequent. Wetting of plumage, especially in cold storms, reduces navigability. Williams (1950) has recently cited again a few classic instances of large-scale disaster:

A dark night must be a wholly clouded one, for the light of the clear night sky, to a man unafflicted by night blindness, enables him to see his way about except in deep forest. Owing to fewer visual rods in their retinae, this would to a certain degree be more difficult to birds. Nevertheless, as recorded above in the section on vision, they are known to find their way about when necessary (p. 65).

Darkness, then, under mild conditions, as at Lazy Bogan, Brandy Brook, and St. Octave, tends to lengthen the period of flight by insuring that birds once in the air shall continue until dawn. Readers who believe that passerines rarely or never descend during the night will consider this statement superfluous. But the writer prefers to leave this an open question.

SPEED OF FLIGHT

Another factor that must be considered is the speed of flight. Robins, which belong to the same family as thrushes, are known to fly at rates between 22 and 36 miles per hour. As stated above, thrushes followed by automobile migrated along the shore at the Dartmouth estuary at a speed of 30 to 32 miles per hour (p. 73).

Assuming a conservative speed of 25 miles average nocturnal speed, how far, for example, could the hermits that left Madeleine Fork in the York Valley at 7:50 P.M. (cf. p. 67) be expected to go during the night? It would require at least one hour and twenty minutes to reach the mouth of the York estuary, and two hours to Point St. Peter at the eastern extremity of Gaspé Bay. If they continued southeast around the coast and followed it without hesitation along the south shore of the peninsula, they would find themselves near the head of Chaleur Bay at 1:30 A.M. Judging from their behavior on the northwest arm of Gaspé Bay, they would then follow the north coast of New Brunswick eastward toward Shippegan, hardly attainable before dawn. A still longer journey was possible in the case of a thrush departing from the Sandy Beach plateau. On the evening of September 18, 1950, the moon, in its third quarter, shone upon an area through which several hermits had slowly progressed southeastward during the day. They had been recorded at dawn as they descended from flight. At 6:53 after *chucks* had advertised the location of at least one of them, a flight note from a bird in young conifers was twice repeated. The following call was louder and came from the open air beyond the trees. One final note a hundred feet distant was interpreted as issuing from this same thrush receding southeast toward the mouth of the St. John River.

Reckoning back from the hillside behind Sandy Beach where thrushes descended to the ground at 5:45–5:48 A.M., September 30, 1948, whence may they have come and when may they have started? If they set out from the remotest headwaters of the York the starting time need not have been earlier than 3:10 A.M. Again, coming from the source of the north branch of the Madeleine River via the St. Lawrence coast to Shiphead and back around Gaspé Bay, approximately 200 miles in 8 hours, would have set the starting time at 9:45 the previous evening. Thrushes from both sources might be expected to pass Sandy Beach. The upper York Valley would be the more likely source, assuming that they left in the early morning hours.

Is there evidence that thrushes do thus begin their flights late in the night? Supplementing the actual departures described above (p. 67) are the following observations. At 5:44 A.M., September 21, 1948, 10 olive-backs descending the east branch of the Ste. Anne River settled into the trees beside the road. The farthest they could have flown along this stream, either from the forest below tree-line on the Tabletop Mountains, or from the high plateau at the headwaters of the northernmost tributary, would have been from 5 to 12 miles, requiring only 12 to 30 minutes. The topography renders unlikely the possibility that these birds had come from regions farther east beyond the highest Shickshocks. Again, if the birds that flew up the Ste. Anne past Moose Gulch (p. 80) at dawn were local residents from farther down the river, they had flown not more than 25 miles, nor for longer than an hour. But if they were of more distant origin they may have flown any distance, a short one from the foothills where they had rested the day and night before, or a longer one, say from Point des Monts 40 miles across the St. Lawrence, plus 25 miles farther up the river. This would have required no more than three hours in the air. Again, they may already have flown some distance before reaching Point des Monts.

LONG-DISTANCE FLIGHTS

These thrushes focus our thoughts upon two aspects of migration in Gaspé—1) long-distance flights, and 2) use of such avenues as the Ste. Anne –Little Cascapedia north-to-south route across the peninsula. Until further studies have been made in the pass about Lake Ste. Anne, and for some distance along the St. Lawrence shore, both east and west of the Ste. Anne's mouth, insufficient evidence can be brought to bear upon these problems. We need to know whether the flight-line along the St. Lawrence shore in this region is east as well as west, and if possible, to obtain records of thrushes crossing the St. Lawrence. Good evidence of migration across the peninsula was obtained in 1951 at Lake Ste. Anne, where several hundred thrushes were recorded flying southeastward on seven successive mornings (p. 127). This would be much strengthened by evidence at the mouth of the Ste. Anne River that birds there turn inland up the valley. Records also need to be made at the point where the river turns north toward the coast, in order to determine whether thrushes at times migrate eastward along the base of the mountains in a direction that would funnel them into the Ste. Anne Valley. Observations at St. Octave, September 25, 1949, showed instead a westward flight (p. 81).

Another sort of evidence concerning the distance that migrants have flown is the length of time spent near the point at which they descend at dawn. This could not be easily determined, for after the first half-hour they usually become very quiet. Observations throughout the day would require caution to avoid disturbance of the birds while resting and feeding. Evening would make them more vocal and might provide an opportunity to hear them begin another step in their journey. In this event one might reasonably judge that the flight of the previous morning had been rather short and unfatiguing. On the other hand, if they remained two or more days in the area, this would indicate a longer flight, possibly a succession of them during the preceding nights from a distant region.

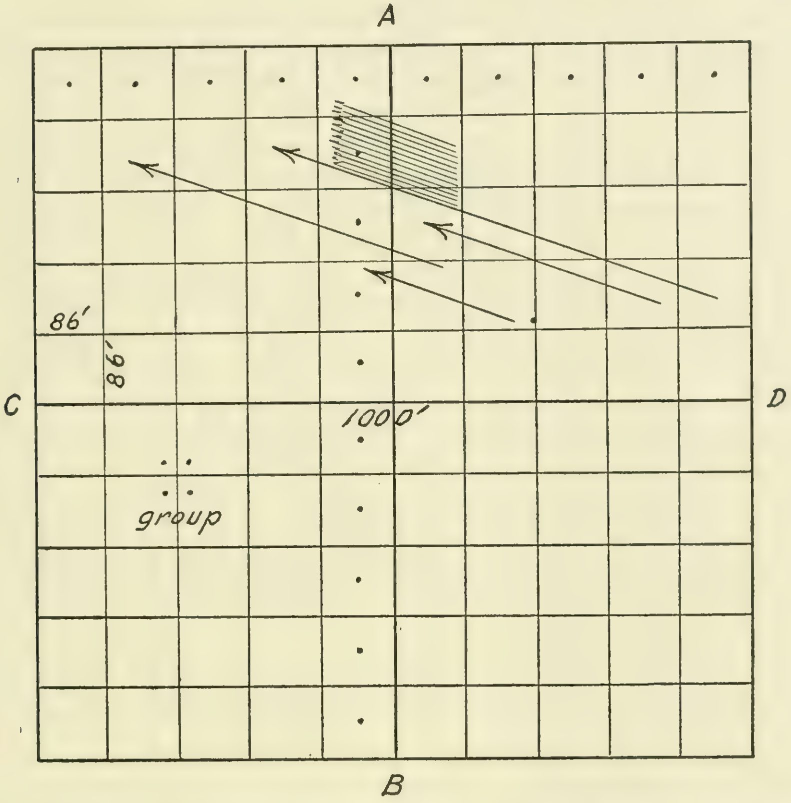


Figure 24. Diagram of possible distribution of thrushes upon descending to ground.

Banding in the north presents obvious difficulties in determining whence these thrushes have come, but if done, should reveal the length of time required in reaching their wintering grounds. The studies of Middleton

(1939) in southeastern Pennsylvania have shown that olive-backs and hermits revisited his traps at intervals of from 2 to 16 days—evidence that they remained in that vicinity for at least such periods.

Spacially, what is the expected distribution of thrushes upon alighting at dawn? Assuming a rather even density of birds while passing a given area in flight, the calculation may be based upon data obtained at Baker's Point woods on the Sandy Beach plateau September 1, 1950. Allowing for some interference with audibility by the forest and the surface curvature, call notes could easily be heard for 500 feet radially from Station 1 (Fig. 24). The direction of flight being indicated by the arrows, one may choose the approximately north-south line AB (500 ft. on each side of the station or 1000 ft.) and inquire how many thrushes may have descended within hearing distance of this line.

Since grounding apparently takes place only during a short period, the question now becomes: How many birds were passing, were about to pass, or had just passed this line during that period—say the 10 minutes between 4:58 and 5:08? One hundred and thirty-four were heard from Station 1. One thousand divided by 134 equals 7.5 feet per bird along the dimension AB. Now they were audible for a similar distance east and west of this line. Therefore, on the average, any one bird per 7.5 feet measured along AB may be conceived to have descended anywhere along other lines intersecting it at 7.5-foot intervals. One thousand squared equals 1,000,000 square feet. Dividing this by 134, each thrush is apportioned 7463 square feet of landing space, in other words, a square 86 feet on a side.

We may now introduce enough irregularity into the pattern to allow a thrush to alight at any point within its square. If those of four contiguous squares were to descend near the same intersection of boundaries they would form a small group like those often recorded at the end of a flight. Perhaps they constitute family groups that tend to associate in flight, and in grounding as well.

INCREASED NUMBERS IN LOWER PARTS OF VALLEYS

It was stated above (p. 74), that on a given morning or evening the number of thrushes heard at any one moment, or throughout the flight, increased toward the mouth of the York River. It is doubtless true of the other streams. This is attributable not merely to the chance that counts were made in the lower part of the valley on nights of heavy migration; for the experience was repeated on several mornings and evenings—all high counts were recorded in the lower valley. On two mornings rapid automobile trips, in reverse direction, during the last hour of twilight permitted the making of brief counts at 28-Mile Hill, Mississippi Brook, Big Fork (Patewegia), Silver (Galt) Brook, and Wakeham. On the upstream test A (Sept. 20, 1941) the figures recorded during 5-minute periods at the successive stations in the order just named were 23, 41, 38, 60, and 85 (total 247); on the reverse test B (Sept. 18) the counts were 7, 18, 21, 35, and 120 (total 201). Experience has shown that more thrushes are in flight, or at least calling, during the last 15 or 20 minutes before dawn than is true earlier. Therefore the numbers should be raised for the downstream stations in A, and for the upstream stations in B. But the latter, it is believed, even after this correction, would still show the downstream increasing gradient.

Since the lower part of the valley is not much wider, and since the breeding population, according to my counts, is fairly uniform throughout the length of the valley, this increase demands an explanation. It has been observed that migration from such areas extends over at least a dozen nights. If all those thrushes that are ready to leave on a given night were to begin their flight at about the same hour, and were to proceed without stopping, an observer stationed near the mouth of the river should hear first the birds from the lower cross-section of the valley, then those from successively more distant belts; there should be no accumulation due to the overtaking of one set by another.

If, however, birds should begin their early flight near the headwaters of the stream, but were to alight a half hour later, they could thus increase at a lower point the number that might initiate another flight on the same morning.

There is abundant evidence that thrushes descend at various stations in the valley at dawn. It is quite conceivable that there often remains at these stations a residue of birds that did not migrate on a given night. These plus the new increment might set out together on a following night, thus accounting for the greater numbers heard in the lower parts of the valley. Observations already made tend to show that, as the migration season progresses, the proportion of calls heard here becomes still greater. Confirmation would then indicate that the higher parts of the watershed (p. 145) are forsaken earlier or more rapidly than the lower. It would also furnish support to the belief expressed in this paper that the migrants recorded descending the eastern and northern valleys of the Gaspé Peninsula originated in those valleys rather than in distant areas (p. 179).

The solution of this problem must account for the presence of thrushes heard migrating down the south branch of the York on September 24, 1947 —late in the season, during a snowstorm, when ice one-half inch thick had formed on quiet pools. It must be remembered also that 7 hermit thrushes were seen October 25, 1941, on the slope above Seal Reef on the Forillon where none nests. The latter and possibly the former may have migrated from far north.

There still remains the possibility that detailed population studies would show a progressive increase in productivity of thrushes from the head to the foot of the York Valley. The relative areas of virgin, cut, and burned forest are roughly equal throughout, but the floor of the valley widens at the foot of 28-Mile Hill and maintains its width nearly down to Big Fork. This extensive basin, burned in 1921, now supports a mixed growth of evergreens, poplars, and birches that provide especially favorable habitats for hermit thrushes. Although the main valley widens but slightly below Big Fork, this tributary, as well as Mississippi Brook above, and others below, exceeded in length and area of watershed the streams farther to the west. If it be assumed that thrushes leave the more remote recesses of these tributaries earlier in the night, and by their calls stimulate into flight others over which they pass in their progress toward and along the main valley, the number recordable, say at Silver Brook, should be greater than at stations farther upstream. More data from the tributary valleys are desirable.

That large side valleys do contribute heavily to the flight in the main valley was well illustrated at the confluence of the east branch with Ste. Anne River as recorded above. Here the tributary is as large as the main stream, and its watershed nearly as great in area as that of the Ste. Anne above the junction. Considerable numbers of thrushes have also been heard descending Mississippi Brook toward the York.

Two questions have as yet received only partial answers: Do resident Gaspé thrushes migrate southward before or after more northerly ones? Do those from the headwaters of large rivers leave before or after those whose territories lie far down the valleys?

Concerning the first of these questions it is well known that in any region the first species to arrive in spring are among the last to depart in autumn. But as to individuals of a species the evidence is less abundant. Confining attention to thrushes, we may infer from Wetmore (1927) that the later arriving gray-cheeked thrushes push on northward after the early arrivals have reached their breeding grounds in the southern part of their range. It is apparent that some at least of the earliest robins to arrive in southern New England in mid-March immediately establish nesting territories, and that later groups of this species pass through to northern homes. The date of autumn departure of our local birds is more difficult to determine.

Bagg and Eliot (1937) report that as early as April 7, 1929, near Amherst, Massachusetts, "rival males [of hermit thrushes] were already proclaiming in song their occupation of the hemlock woods on the north side of Mt. Tobey." A week later according to these authors, Dr. Herbert Friedmann saw a flock of more than 1000 of these birds, evidently migrants, settle to feed in a field at Amherst. "By the middle of May these migrants have passed on . . . and residents are nesting." Although other hints appear scattered through the literature, no one seems to have published the results of a study designed to establish the status of different segments of a widely ranging subspecies from the standpoint of areas and dates. As yet I have not had the opportunity to record the spring arrival of either resident or transient thrushes in Gaspé. Territories are already established by June 4, my own earliest arrival, and no migrants were heard in June.

In the autumn, although no evidence of flocking has been obtained, adult hermits and first-brood young disappear from the Sandy Beach plateau before the young of the second brood depart. The latter were in evidence daily through September 24, 1950, when the third immature bird of one late brood was taken. It still showed light buffy spots on the back and scapulars. Evidence has been recorded above that migrants, presumably from the north, enter the Forillon as late as October 25 (p. 143). But throughout

October the numbers of migrant thrushes are much smaller than during late August and September (Table 3). Resident robins (*Turdus m. migratorius*) flock, feed on blueberries until frost ruins them, and then depart in late September. Throughout October and even in early November other robins, presumably from the north, pass through, often stopping for a few days in Gaspé. Seven inches of snow on October 11, 1941, failed to stimulate one large group into farther flight. The birds remained until the snow melted three days later; *Sorbus* berries were abundant.

In answer to the second question it is yet to be confirmed that, as suspected from certain observations, some of the earlier heavy movements of thrushes originate in the upper parts of Gaspé river valleys.

ORIENTATION

The data obtained in Gaspé fail to indicate strong power of orientation toward the south in the early stages of migration by passerines. Instead of rising immediately from their nesting grounds to a height that would carry them over the mountains and infallibly southward across the peninsula, we have seen that they restrict themselves to low altitudes, and may fly eastward, northward, and northwestward.

This behavior may, of course, be regarded as a trial to discover the coastal path southward. But there seems little evidence of error or random wandering, as in the case of gulls, terns, and gannets liberated far from their nests by Griffin (1943) and Griffin and Hock (1948). One hesitates to attribute to thrushes a "power of absolute orientation" as Griffin (1940) was compelled to concede to petrels, and as seems probable in the Manx shearwaters transported from Wales to Venice, Italy, by Lack and Lockley (1938). Thrush procedure on the whole is remarkably effective. Once having attained the coast, avoidance of water, rather than a southward orientation, appears to be the guiding force (p. 27). So powerful is it that migrants even turn northwestward along the Forillon, and adhere rigorously to the shores of small bays rather than shorten the distance by crossing them. It was nowhere shown more clearly than at the triangular peninsula that extends for a mile into Gaspé Bay—narrowly attached to the north shore by its northeast angle. At this point thrushes and warblers flying westward along the shore frequently turned slightly to the left (southwest) upon the peninsula. But all eventually return to the mainland to continue their westward flight. Of birds proceeding eastward along the coast none were observed crossing the narrow lagoon's mouth to reach the northwest corner of the peninsula. That no eastbound birds even at the northeast connection veered southward upon the peninsula is less surprising for two reasons: first, the eastern margin actually would have required a sharp turn to the westward, and secondly, birds in general avoid peninsulas whose shores require a marked change in their direction of flight (Fig. 10); for example, no thrushes were recorded turning out upon the Sandy Beach peninsula from the south shore of the bay.

Of the four recorded instances (p. 67) in which thrushes initiated nocturnal flights, one concerned birds that struck out southeastward, downstream from the mouth of York Lake, one eastward from Madeleine Fork. The individuals of the two other cases, both on the Sandy Beach plateau where directive horizon lines were wanting, satisfied the conventional picture of departure almost directly southward (SSE) toward the St. John River. Doubtless upon reaching its estuary they conformed with the usual pattern of flight there and followed the coast.

Another bit of evidence that a southward urge animates some of these night migrants may be found in the observation that thrushes have flown upstream only in valleys that trend northward. This may be ascribed to a weakened response to the descending horizon line when that would carry them away from a course directed in some degree southward. As long as the valley extends eastward, thrushes that find themselves within it descend to the coast. If the minority that was heard ascending the Ste. Anne and Fox rivers was native to these valleys, the birds may have had at that time an increased sensitivity to other stimuli, as yet unknown, that attracted them southward. But the fact remains that a greater number, at least on the Ste. Anne, passed north or northwestward down the valley. Possibly to them the descending sky line was the more powerful stimulus.

The above remarks are intended to apply to birds setting out on their migration from some point within the Ste. Anne Valley. There is another possibility; these thrushes may have left the main flight-line along the coast to enter the Ste. Anne or Fox River valley in response to unknown stimuli that influenced them to take advantage of a direct path southward.

Why birds beginning their autumn migration eventually turn southward instead of northward is a question distinct in some degree from the question as to what directs them southward once they have begun flight. An appeal to instinct and racial memory explains little. In order to reduce the physiographical environment to its simplest terms, we may choose a sparrow that has dwelt through the summer in a broad expanse of prairie, or a duck in the flat lake country of Saskatchewan where landmarks appear at a minimum. Assuming the bird to be physically and physiologically prepared for migration by the completion of the molt, an abundance of fat, the presence or absence of hormonal activity, etc., why upon rising from its territory does it not turn northward?

No acceptable answer has been found in star guidance, lighter sky in east or west, wind direction, or atmospheric pressure; for, as shown for thrushes in Gaspé, birds depart not only on starry but also on cloudy nights when the sky lacks character, at times when winds may blow from one direction or another, or during calm weather. Any imaginable stimulus that may guide a bird in the course of its migration may by its presence or absence serve both spring and autumn movements. Even contrary winds, unless of great force, fail to prevent thrushes and warblers from proceeding in the proper direction. The question still remains—why does our sparrow or duck eventually, of not at once, turn southward? Magnetic fields, Coriolis, and gravitational forces, etc., even if sensed at all by birds, could no more enable them to distinguish north from south than the name of a street sign, regarded by a person entering it from a side street, can direct him to a given house without further means of orientation—street numbers, position of the sun, or knowledge that his destination lies toward the right or the left. Although birds undeniably evince powers of recognition we must keep in mind their low order of intelligence. Little wonder that mention of "innate tendencies" is often made.

As recorded in this paper, Gaspé thrushes, when presented with a choice between two avenues apparently equally attractive, by no means always depart southward. Some, as at the summit of the Fox River portage, at dawn turn northeast instead of southward down a valley leading to Gaspé Bay. In this case a greater intensity of light in the east was given possible credit as the deciding stimulus. However, this factor is not always effective in Haldimand at the juncture of the St. John estuary with the bay; for occasionally birds have turned northwest up the shore in the dawn twilight instead of eastward toward the gulf. Furthermore, thrushes in autumn pass both north and south on the Ste. Anne River (p. 80).

Having once reached the coast, why do they follow it in a direction that eventually leads southward in autumn? Presumably they retrace it in the spring, involving a reversal of response.

As a brief outline of the direction changes made by a bird leaving its Gaspé home, we may review on the map the passage of a thrush from the head of Second Fork, northward to the St. John River, eastward to Gaspé Bay, southeast to Point St. Peter, around the end of the peninsula to the Bay of Chaleur, and thence toward Matapedia—a giant U-shaped course. But now we have stepped over into the domain of direction factors operating on the bird after it has begun its southward journey.

That the thrush leaving the York Valley does not turn back up some other stream may seem to be due to the greater conspicuousness of the coast—say at the mouth of the Cascapedia. But in the spring the ascent is made, presumably without hesitation. As a matter of fact, we have recorded thrushes ascending the Ste. Anne and Fox rivers in the fall, although they have not actually been seen entering the river mouths from the coast. That they avoid the entrances to southward-flowing rivers on the Chaleur Bay coast serves to confirm the surmise that birds flying up northwardly flowing streams are exercising their power of southward orientation.

No evidence is available of an external factor that could alone direct a bird out of a valley in autumn and into it in spring. Again we must look ultimately to the physical, physiological, and psychological condition of the bird for the solution of this problem. Indeed, the experiments of Rowan and others show that in mid-winter juncos and crows can be induced to fly northward by changing the state of their endocrines and deposits of fat.

RE-ORIENTATION: CONFUSION OR INDECISION ON PENINSULAS

I have recorded above (p. 36) the interesting behavior of diurnal migrants on and above the strange low, flat, triangular bar, known as "Peninsula," that extends for a mile into Gaspé Bay from its north shore (Fig. 10). After dawn a considerable number of warblers traveling northwestward along shore from the Forillon followed the tree-line leading out upon this peninsula. Upon reaching the outer border of the coniferous forest all but two returned to the north shore, flying from the northwesternmost trees to Ascah's Point, a distance of only some 400 feet across the mouth of the lagoon. The two exceptions, a pair of myrtle warblers, set bravely forth over the bay toward the opposite shore 2 miles distant. But, as in a few other such cases at Shiphead and St. Peter, they too, soon rose steeply as though better to scan their surroundings, then veered back to the north shore. Previous studies had shown that thrushes likewise passed westward at dawn along this shore on their journey around the bay. It was also known that a relatively few at times fly in the opposite direction past Little Gaspé and Grande Grève.

Against this background may now be projected the pattern of thrush movements that were recorded at Peninsula on the morning of September 15, 1950. For a few minutes after my arrival at 4:28 quiet prevailed. Nor had any passerine voices been heard during the half hour's drive around the bay from Sandy Beach. Since 3:00 A.M. (temp. 10°C.) clouds had been gathering, although the wind still blew moderately from the southwest.

At 4:36 the first thrush notes came in to Station 1 over the outer point of the triangle, suggesting that in silence a pair of birds bound westward had turned along the outer peninsula shore, had over-run the tip, and then turned back as they began uttering their communicative notes. Two others at 4:38, and one at 4:40, piped just off the outer point, unfortunately without enough notes to establish the direction of flight. But between 5:03 and 5:10, 10 thrushes were easily traced northwestward along the outer margin of the forest. One bird deserves special mention. Calling rapidly, its course was easily traced as it approached along the eastern beach from the main shore. Nearing the tip it curved to the right over Station 1 and continued on its new northwest course. There can be little doubt that all these birds proceeded onward up the north shore.

A group of 3 olive-backs, calling sharply and often, crossed the outer beach squarely at 4:39 and continued directly over the forest and air field toward Ascah's Point. Their path and excited behavior suggested that they had exceeded all the other birds in their flight over the water, and therefore became the more intent upon regaining the coast.

While walking from Station 1 toward Station 2 (4:50–5:00 A.M.) several more thrushes passed westward. Now, at the northwest point of the peninsula the opposite stream of migrants became audible; at least 35 passed eastward along the main shore and the lagoon between 5:01 and 5:10. On account of distance it was impossible to determine whether any of these birds turned outward upon the peninsula as they neared the neck-like isthmus. It is at least certain that while these 35 birds were flying eastward 10 others passed in the opposite direction up the bay shore.

The fact that no eastbound thrushes were heard over the peninsula is not surprising in view of the absence of a land connection with Ascah's Point; for they had been flying low above the land just back of the line of shore cliffs, evidence that the outlines of shore were visible in the early twilight. Therefore, upon reaching the Point they tended either to continue their course unswervingly, or to veer slightly to the left in order to keep the shore below them. In other words, like the diurnal migrants here, they avoided all unnecessary crossing of water. The terrain on their left, rising massively to a height of 1500 feet, must have caused a degree of thigmotropic response. On the other hand, the peninsula, being low and absolutely flat, failed to attract them.

On this hypothesis the thrushes returning westward were subject to the same stimuli of shore line and mountain. Nevertheless the continuity of the shore line along the little isthmus and the peninsula attracted at least 17 birds outward as explained above. To them no water barrier was presented. By stationing oneself at the juncture of the isthmus and shore it would be possible to determine whether some eastbound birds swing out over the peninsula while their companions continue toward the Forillon, and also whether some of those coming westward continue, uninfluenced by the southward projecting peninsula. This would be expected to occur; my failure to detect it on this morning may have been due entirely to my early station more than half a mile from the main shore.

Confusion, or at least momentary indecision, was shown by some of the thrushes that reached or over-ran the end of the peninsula. Like the diurnal warblers cited above, these birds probably veered and towered, probing the twilight for their next objective. Confusion of another sort occurred near the inner (northwest) corner of the area. At 5:00 o'clock several thrushes, including both hermits and olive-backs, had just descended into the marginal bushes and scattered spruces among the low sand dunes bordering the lagoon. As 2 birds passed just above the ground from one tree to the next I was standing motionless by the second tree. One thrush darted into its protecting branches; the other, in the twilight, apparently regarded me as a possible stump, for it fluttered for 10 seconds against my hip before joining its companion.

Another instance of apparent confusion among migrants when confronted with a peninsula was recorded at Sandy Beach, September 12, 1950. The sky was mostly clear; wind southwest 10 m.p.h., and white frost covered the ground. Sandy Beach derives its name from a bar that extends obliquely northwest from the south shore nearly 2 miles into the bay, and toward the peninsula described above (Fig. 10). Its large triangular base, a mile in width, at high tide is about half covered with water.

At 4:36 A.M. the first olive-back was heard flying eastward along the shore from the head of Gaspé Bay. As it reached the base of the peninsula its calls clearly indicated that this thrush turned outward along the bar, circled back to the main shore and proceeded again eastward at 4:38.

This occurred 16 minutes before the dawn light intensity had reached

0.0001 f.c. In the meantime (4:42–4:44) 2 more olive-backs came down the shore without being led off their course by the bar, as did 2 others that a minute later followed the same route. The first bird's temporary change of course, although exceptional at Sandy Beach, is cited as indicating how easily a migrant may be influenced by topography.

MAJOR FLIGHT-LINES

A map of eastern Canada and the known breeding ranges of thrushes (p. 48) suggests several major lines of flight open to migrants. From the vast reservoir north of the St. Lawrence one would predict, assuming the broad-front type of migration, a general flow of birds southward across the river and its gulf in the fall. Thus far no records of such entry over Gaspé have been obtained. Attempts should be made along the north shore, especially near Matane, opposite which Pointe des Monts marks the easternmost point on the river where nocturnal migrants could see Gaspé—a distance of 25 miles. Another good listening post, Cap des Rosiers near the base of the Forillon, has as yet yielded no records. As stated earlier in this paper (p. 22), and more fully in the article on nuthatch migration (Ball, 1947), no calls of birds landing on the Forillon at night were heard during several years of study. Only by extremely good fortune could success there reward such efforts, for unless a large number of birds left Anticosti simultaneously or within a period of short duration—a few hours—the small component groups might reach the Gaspé coast well separated spacially, if not chronologically. Coöperation of several observers might succeed where a single one has failed. One may here resort to the possibility that such migrants across 45 miles of water would rise to such height as to pass unheard above the Forillon. Possibly this is true of birds that leave Anticosti in the earlier hours of the night; under favorable conditions the distance would require not more than one and one-half hours to bring them over the northeastern shore of Gaspé. Recalling that thrushes have been recorded leaving the ground during various hours from evening to early dawn, and that their calls are heard chiefly at dawn, that hour would most likely yield records of birds that left Anticosti during late hours of the night. Were migrants leaving the Labrador coast or Anticosti to seek the high levels observed by Rense (1946), Lowery (1946), or Williams (1950) they might not descend to audible elevation over the Gaspé coast.

Only at the base of the Forillon were a few thrushes heard passing southeast over the Break, Grande Grève, and on across the bay as though flying a general southeasterly course down the coast. Although this course may have brought them across the wide mouth of the St. Lawrence from its northern shore (Course B, Fig. 25), it is believed that these low-flying birds had been following the northern Gaspé shore for some distance. Course C lies in the direction followed by so many thrushes recorded above the southern shore of Gaspé Bay, but these birds, as explained above, were low-flying migrants that were believed either to have come down the rivers, or to have swung around the bay from the Forillon. In other words, they were migrating in a coastal fly-line rather than a broad front.

Courses A and D are as yet unrepresented in the records. It may be pointed out that should birds follow D, they would be flying in the same direction as were those thrushes heard ascending Fox River.

Since thrushes breed all about the Gulf of St. Lawrence, and within it upon Anticosti and the Magdalens, one may envision a general north and south migration across the gulf. On the other hand, there may be a line through Newfoundland between Labrador and Cape Breton, and another through eastern Gaspé and Anticosti to the north shore of the gulf. The former is suggested by the statement (Macoun, 1909, p. 741) that the olive-back is a "tolerably common summer migrant in Newfoundland." That a fly-line through Gaspé to Anticosti exists seems doubtful because, 1) observations of such a movement are lacking on the Forillon, 2) most of the island lies northeast of Gaspé, and 3) the species breeds on the Magdalens. Studies conducted on these little islands in the center of the gulf are needed to determine whether considerable numbers of thrushes migrate through them.

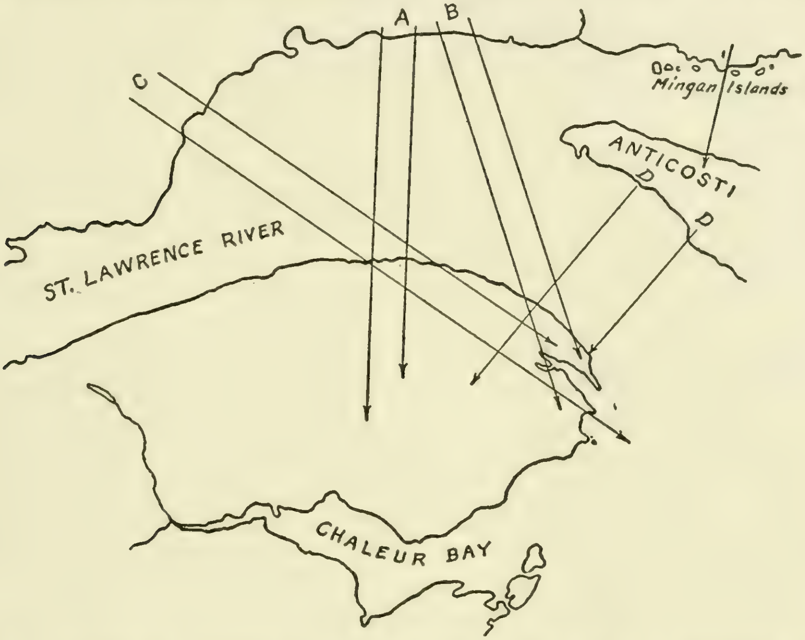


Figure 25. Diagram of theoretical flight courses across the St. Lawrence River to Gaspé.

Few who write of the migration, homing, and orientation of birds can resist a statement concerning those that each season reach their island territories. Racial and individual memory, homing instinct, sense of direction, response to the earth's magnetic field, random wandering with recognition of old haunts, use of prevailing winds, recognition of stars, and other reactions and methods have been attributed to such birds as the terns of Tortugas, Laysan albatross, and many others. Some of these abilities and responses are concerned with the return of land birds to both their nesting and wintering territories.

Unless we credit the bird with greater infallibility in its behavior than now seems reasonable, small islands should be more difficult to find than large ones. Nevertheless migratory passerines of several species nest successfully each year on these small Magdalen Islands (Fig. 1). They lie near the center of the St. Lawrence Gulf 55 miles from the nearest land, Prince Edward Island on the south, and 58 from Cape Breton on the east. This seems more remarkable than the return of the same species to Anticosti, an island 135 miles in length from east to west, lying in the broad throat of the St. Lawrence River athwart the generally conceived north-south migration front of birds.

The principle of accurate return to nesting territories supports the hypothesis that rather than a broad front of thrushes migrating northward over the gulf with individuals or groups descending to their recognized homes—Magdalens, Anticosti, etc.—the true over-all picture of spring migration here is of individuals or groups loosely spaced in units seeking their proper goals.

Actually, judging from the visibility of Anticosti on a clear day from the Forillon's cliffs at any height above 400 feet, birds leaving Prince Edward Island, without rising to great heights, may be able to perceive the Magdalens. The distance across the gulf is exactly the same. Furthermore, Grindstone Island, southernmost of the group, is low, like the southern part of Anticosti, while Bird Rock farther north stands in the same relation to Prince Edward Island as do Anticosti's northern mountains, 700 feet in height, to the Forillon. But we must bear in mind that as a rule thrushes and sparrows, at least when over land, are nocturnal migrants.

Fortunately we have an instance of daylight departure of northbound migrants (turkey vultures, hummingbirds, swallows, and shore birds) from the Yucatan coast on their journey across the Gulf of Mexico (Van Tyne and Trautman, 1945). Although this case is not strictly comparable, since no islands were visible, it suggests the possibility that some birds leave Prince Edward Island or Cape Breton by day and could, therefore, easily see the Magdalens. Daylight *approach* to Yucatan was witnessed by a correspondent of Paynter (1951). Thirty kilometers off the northern coast, August 30, 1949, 2 exhausted birds came aboard a fishing vessel, and 2 other groups were seen flying over the boat from the north. Again, on September 3, some 50 caprimulgids were observed from the boat, flying south toward shore.

Birds may wait on Prince Edward Island until dawn to make their departure; the Magdalens would be invisible at the start. Thrushes could complete the flight in two hours, the sparrows in but little more. To continue conjectures as to time of departure in order that the birds should not miss their mark in the darkness would serve little more than to raise again the question as to their ability to see their destination and make a landing at night. I believe they could do so after reaching the vicinity of the islands. The chief problem of how they gain this vicinity remains in the realm of conjecture.

As yet no banding studies have been made on the residents of these islands, but there can be little doubt that, as on the mainland, individual birds return to them repeatedly to occupy their former territories. The principle that populations of a given latitude or region tend to return annually may be expected to apply. It is true that, in the course of a general ebbing and flowing of Savannah sparrows, for example, across the St. Lawrence Gulf, many individuals would pass within sight of the Magdalens. Of these some whose natal territory lay on Anticosti or the coast of southern Quebec might drop down and remain for the season on Grindstone Island. Banding records from these little islands would be valuable.

In considering the likelihood of a given bird successfully migrating northward to the Magdalens there is the comforting assurance that, if he missed it, he would strike land to the northward within 165 miles at the farthest. Without banding, no one finding a bird on Anticosti could determine by inspection that it had not previously resided upon the Magdalens.

The famous case of the Ipswich sparrow (Dwight, 1895), essentially a large pale Savannah, known to breed only on tiny Sable Island, isolated in the ocean east of Nova Scotia (Fig. 1), raises interesting questions. In migration it is restricted closely to the Atlantic coast—usually to beaches and dunes within a few hundred yards of the ocean. And yet, as Palmer (1949) states, most of these birds undoubtedly cross the sea from the Massachusetts shore to Nova Scotia. Thence the birds find their way to Sable Island 465 miles northeast of the southern point of Nova Scotia and 170 miles southeast of its northern extremity—the shortest possible distance over the ocean. One cannot but wonder what per cent of these sparrows leaving the Massachusetts coast successfully complete their journey. It would be interesting to search for records of Ipswich sparrows along the eastern coast of Nova Scotia and Cape Breton, and also in southern Newfoundland. If they were to rely upon random wandering, their breeding range should have spread to these other shores, or else too many would be lost at sea and their numbers decrease on Sable Island.

Since winds are not always "prevailing" and since sparrows are nocturnal migrants, our difficulties in trying to understand how these birds so successfully complete their annual journeys seem undiminished. Apparently they "know" where to leave the coast of New England on their northward flight, for the records of the species along the coast of Maine show rapid decrease in numbers above Cape Elizabeth (Palmer, 1949). This indicates that the Ipswich sparrow flies at least 110 miles in crossing the Gulf of Maine. The reverse movement in autumn is just as successful.

Now, Anticosti Island lies across one of the conceivable migration routes between Quebec Labrador and northeastern Gaspé. By day birds can easily see land beyond the waters that separate the island from either coast—30 miles on the north and 45 on the south. To nocturnal migrants this advantage would be denied at the time of departure.

SOURCES OF MIGRANT THRUSHES RECORDED IN GASPÉ

In attempting to determine the sources of thrushes heard and seen migrating in Gaspé we must investigate, 1) the numbers and paths of migrants, 2) the size of local populations in northeastern Gaspé, 3) the use of mountain passes, 4) West Gaspésian migrants, populations, and passes, and 5) the migration of thrushes originating outside of Gaspé, particularly from areas west and north of the peninsula.

NUMBERS AND PATHS OF MIGRANTS

Do the numbers of thrushes heard migrating suggest that they are chiefly residents, or that many have entered Gaspé from the north or west? In the fall of 1947 the figures from various stations in the northeastern part of the peninsula were as follows:

Fox River portage	50
Dartmouth River valley	450
North shore of Gaspé Bay	25
York River valley	1775
Sandy Beach	125
St. John River valley	900
South shore of Gaspé Bay	225
Percé	250
Total migrants	3800

Of these, 3475 were counted on six mornings in the valleys of the Dartmouth, York, and St. John, and along the south shore of the bay to which many of them are known to have come from these valleys. These watersheds include approximately 1300 square miles.

SIZE OF LOCAL POPULATIONS IN NORTHEASTERN GASPÉ

In 1949, population studies were made on two plots of one square mile each. One of them occupies a plateau behind Sandy Beach at an elevation of 300 feet. About 90 per cent of the area was burned by a forest fire in 1935. One-half of this surface has become covered with brakes (*Pteris aquilina*), blueberries (*Vaccinium*), fireweed (*Epilobium*), and sheep laurel (*Kalmia angustifolia*). The remainder supports a growth of scattered poplars (*Populus tremuloides*), canoe birch (*Betula papyrifera*), red maple (*Acer rubrum*), mountain ash (*Sorbus americana*), and pin cherry (*Prunus pennsylvanica*). The oldest of these trees reach a height of 15 or 20 feet. Most of the original fire-killed spruce (*Picea*), and fir (*Abies balsamifera*), and much of the white pine (*Pinus strobus*) has fallen. About 50 of the latter still stand, and are much frequented by birds. Hermit thrushes especially use them as singing and sunning posts.

Daily records of singing males were kept from June 13 through August. Data from June 15 to July 15 established territories for 81 hermits and 23 olive-backs on this Sandy Beach tract. These 104 pairs represent a population but slightly greater than Kendeigh (1944) found for wood thrushes in Ohio, New York, and Virginia, 101 pairs per square mile. Reckoned in 100-acre squares, which are more suitable for recording density on small areas, the average would be 16.2 pairs.

In about one-third of the York Valley similar environment obtains; there also fires have taken their toll. In 1921 many square miles in the central part of the valley were burned. Replacing the original conifers are poplars, birches, and maples, some of which have attained a height of 20 feet. Again in 1941 a fire swept the southwestern quarter of the watershed. Hermit thrushes began to frequent this "burn" in 1949. In addition, a considerable aggregate area of timber has been cut, producing a somewhat similar habitat, which likewise favors the hermits.

The remainder of the York watershed still supports a virgin forest, almost purely spruce and fir. This type of cover attracts a preponderance of olive-backs; indeed, so few hermits breed here that we may omit them from our calculations. About York Lake, headwaters of the main stream, a square mile of forest contained territories of 86 singing male olive-backs.

If three-fifths of the 81 territorial male hermits recorded on the Sandy Beach tract obtained mates, 48 nests would have received somewhat less than 4 x 48 eggs—somewhat less than 192 say 172. The number of first-brood young leaving the nests was probably not more than 55 per cent of this number, or 96. This percentage of success is much lower than the 78 per cent found by Twomey (1945, Table 7) for the wood thrush (*Hylocichla mustelina*), and on the other hand is much higher than the rate of 24.4 per cent found by Wallace (1939) for the Bicknell's thrush population on Mt. Mansfield, Vermont, for the 1935 season. It is believed reasonable because of observed predation by foxes (*Vulpes fulvus*) and red squirrels (*Sciurus hudsonicus*). The former are numerous on the Sandy Beach plot, as well as in the York Valley "burns." Here also conifers in some numbers have reached fruiting size and attract an increasing population of squirrels. To the fox the ground-nesting hermit often falls prey, while the squirrel hunts both on the ground and in trees occupied by olive-backs. Jays and bears also take their toll. Of the 96 juveniles of the first brood probably not more than 80 would have survived to migrate. Estimating at 60 the number of second-brood migrants, we have a total of 140 immature migrants.

Forty-eight times 2 equals 96 parents, plus 33 unsuccessful males plus 10 such females, equals 139 adults present July 15. A 25 per cent reduction during the summer would have left 104 adult migrants. The total of migrant hermits per square mile would have been $140 + 140 = 280$.

Since olive-backs lay but a single clutch of 4 eggs, $^{23}/_{81} \times$ (80 young + 104 adults) = 52 migrants of this species from the Sandy Beach area. Total hermit and olive-back migrants, 300 per square mile in the "burn" type of environment.

The York watershed embraces some 525 square miles, of which about 175 are of this hermit plus olive-back type, and, on the basis of the territorial density on the Sandy Beach areas in 1949, may be expected to yield 175 × 300 = 52,500 migrants. The remaining 350 square miles support chiefly mature forests of spruce, fir, and arbor vitae (*Thuja occidentalis*), principal habitat of olive-backed thrushes. Although 86 singing males were counted in the square mile about York Lake, the population is less dense in the unbroken forest. Taking 60 as a conservative estimate, and following the procedure used in calculating the number of hermits, $3/5 \times 60 = 36$ nests × 4 = 144 eggs × 55% = 79 immature leaving nest, of which 70 might survive to migrate. Parents, 36 × 2 = 72, plus 15 non-breeders = 87 adults July 15, reduced by 25% = 65 adult migrants. Seventy-nine + 65 = 144 migrant olive-backs + 10 scattered hermits = 154 thrush migrants per square mile. The forested portion of the York Valley would thus yield 350 × 154 = 53,900. This number added to 52,500 from the burned and cut-over portion gives 106,400, the total migrant thrush population of the York Valley in the autumn of 1947.

This number is still probably too high, but will serve as a basis of comparison with the numbers of migrants recorded aurally—1775. This is less than 2 per cent. To this number may reasonably be added 2000 that probably passed down the York on mornings when records were being taken in other parts of the peninsula, giving 3775. Since it is not believed that more than half the birds passing down the full width of the York Valley can be heard from a single station, however well chosen, we can raise to some 7550 the number of resident thrushes that left this valley at its mouth (7% of the population). Stated in another way, only 21 of the 300 thrushes calculated per square mile of "burn," and 10 of the 154 per square mile of forest, were recorded in departure. This leaves unaccounted for some 98,850 or 93 per cent of the migrants believed to have originated in the York Valley.

Before having recourse to high-level migration directly southward across the peninsula, other possibilities need exploring. As explained above (p. 168), no nocturnal migrants have been heard traveling directly south high above Gaspé mountain tops. The 12 thrushes observed on Tabletop, later to be explained, are regarded as valley migrants that ascended one of the northerly trending valleys. It is probably true, however, that some of those living near the divides between the York and St. John and the southerly flowing Grande River, Pabos, and Bonaventure pass into those valleys either as nocturnal migrants, or more likely while feeding along slowly during the day.

MOUNTAIN PASSES USED IN MIGRATION

Another outlet exists in north-south passes between major valleys. The most important of these leads from one of the southernmost bends in the York to the St. John through the valley of Caribou Brook. Data recorded on this brook September 10, 1949, have already been reported in considering paths of migrants (p. 44). Due to unfavorable weather—clouds breaking after rain and southeast to north winds—only 30 thrushes flew southward up the gentle grade of Caribou, and 4 others grounded at dawn. Three days later, however, 225 flew south-southwest at Garland's *up* the York toward the mouth of Caribou, only 1½ miles away. It is believed that these birds used the pass, the earliest ones on that same morning, and the later ones the following night.

Toward the Caribou bend many thrushes also descend southeast from York Lake region and from the mountainous watershed of the South Branch. It may prove that some of them never reach Caribou Brook, but use another pass to the St. John about a mile to the west. This would require a 300-foot ascent of Pond Brook, instead of 200 feet as at Caribou. A more important difference is that no such change to a north-northeast direction occurs in the York River at the mouth of Pond Brook. On the other hand, comparable to the portion of the York between Whitehouse and the Caribou bend, an obvious southward avenue is provided by Oatcake Brook which enters the York exactly opposite the mouth of Pond Brook. An observer far up Oatcake Brook has a clear view southward through the pass.

It is believed that most of the thrushes from the western third of the York watershed make their southward journey through the Caribou and Pond Brook routes.

Twelve miles farther east the York again approaches the St. John from the northwest to recurve somewhat abruptly northward. Here another northward-flowing stream, Dinner Island Brook, enters from the divide that rises 400 feet above the two rivers. Although no observations have yet been made there, the southward view from the north bank of the York should be attractive to autumn migrants. We have seen many cross a divide 400 feet high between the York and the St. John near their mouths (p. 77).

Obviously, thrushes leaving the York Valley in this way enter that of the St. John, and could be included among birds recorded at its entrance to Gaspé Bay. Possibly thousands not taken into account above (p. 156) passed through Haldimand West and Douglastown at times when I was occupied elsewhere. More observations also should be made in passes south of the St. John. Three branches of Indian Brook (Fig. 2), a major tributary, arise at 1300 feet elevation near the origin of brooks flowing south into the Grand Pabos and the Bonaventure.

More advantageous should be the valley that leads east-southeast from the point where the St. John curves strongly northward. From the head of this valley, not yet studied, a pass 950 feet in elevation leads into another valley belonging to Second Fork, a larger tributary of the St. John. By turning southwest and ascending Second Fork, birds could easily cross the divide and enter the valley of the southwardly flowing Grand River. This problem has already been approached through observations made at dawn September 27, 1950, in the pass across this divide. Making use of a new road to one of the oil wells for which drilling had recently begun, a trial run before dawn was made over the divide to the upper waters of Grand River. After gaining as much familiarity with the topography of the region as was possible with aid of automobile lights, I returned to the St. John end of the critical pass, and occupied Station No. 1 at 4:20 A.M. (Fig. 26). At this hour the moon, two days after "full," shed light of intensity (0.015 f.c.) sufficient to allow use of the field book without the aid of a flashlight. Incidentally, the intensity was somewhat reduced by a pall of smoke that had been carried eastward some 2500 miles from extensive forest fires then devastating parts of Alberta. The moon's face wore an alluring pale saffron blush. At 5:15 the light intensity of dawn (0.001 f.c.) had not attained that of the moon a half hour earlier.

This deficit had been removed by 5:20 when the first call of a migrant thrush was heard. Three more birds piped at 5:25. None of these first 4 thrushes called often enough to determine the direction of flight, but at 5:27 a group of 8 was readily traced as it approached Station 1 from the origin of Second Fork farther westward, swung to the right overhead, and flew through the wooded pass toward Grand River. Although the courses of two succeeding small groups could not be determined, a flock of 7 birds also turned southward at 5:32. The next birds, a group of 10, passed down the Fork northeastward (5:33). Between 5:35 and 5:38, 70 were recorded, the majority of them veering through the pass. The first ground note was registered at 5:39; 4 others had descended a minute later. By 5:43 their calls had ceased.

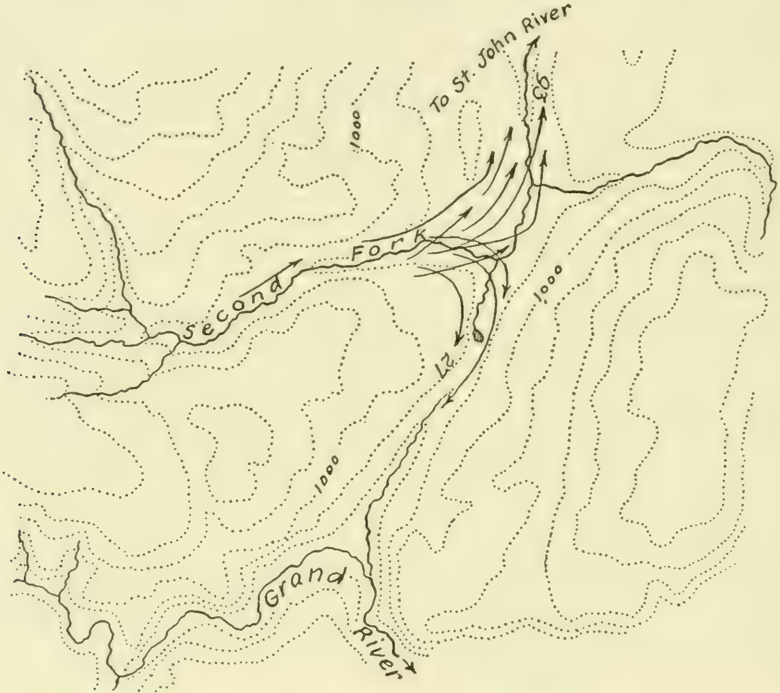


Figure 26. Migration of thrushes through pass from St. John Valley to Grand River Valley.

It should be stated that all birds heard on this morning likewise apparently came from the west. Since contour maps of this region show only high divides between the headwaters of Second Fork and other valleys of the St. John and Grand rivers, one might reasonably conclude that the thrushes recorded on this morning were local residents just leaving their home territories. However, the lateness of the season and the presence among them of some gray-cheeked thrushes not known to nest in this area rather indicates a more distant origin.

No migration of thrushes up Second Fork from the St. John was detected, nor were movements of other species evident. Indeed, on the return trip no birds of any kind were seen between Station 1 and the confluence of this tributary and the parent stream. Three miles farther east on the St. John an aggregation of some 50 white-throated sparrows, 25 juncos, and 10 myrtle warblers was feeding in a clearing that was well stocked with grass and weed seeds. Although much playful chasing to and fro took place, the group as a whole was disappointingly static for the half-hour available for observation.

Therefore the possible use of this big tributary as an avenue for migrants southbound from the main St. John Valley remains unconfirmed. However, the fact that many of the thrushes from territory about the upper part of Second Fork did swing southward into the Grand River watershed is important. It furnishes additional evidence that passes through the mountains attract birds.

All those robins and myrtle warblers recorded earlier flying westward along the lower part of the St. John must leave the valley somewhere. Possibly some of them may be found to use the Second Fork outlet to the south, conspicuous to birds flying upstream.

It will have been noticed above that the general current of migrants from the headwaters of Second Fork became divided, as it were, some continuing down the stream, others curving to the right to enter the pass toward Grand River. Actually however this splitting was not observed to occur within a single flock. Rather it appeared that one group or another, as a unit, followed alternate paths. This dichotomy has previously been recorded in the Fox River pass, also along the Cape Road behind Grande Grève, at Battery Park near the mouth of the York River estuary, and can be inferred to take place among westbound thrushes at Peninsula. It certainly occurs there among diurnally migrating warblers. Possibly heredity and tradition are concerned here. At the mouth of Whitehouse Brook migrants turn both southward upstream and eastward downstream.

The probability seems great that, like Caribou Brook on the York, these tributaries of the St. John lead many birds southward through mountain passes. Only further study can determine their numbers. Then one may judge whether, of the calculated population of the York and St. John valleys, the great majority not found leaving the mouth of these rivers can be accounted for in this way.

WEST GASPÉSIAN MIGRANTS, POPULATIONS, AND PASSES

The tentative conclusion that most thrushes heard migrating in Gaspé are residents brings us back to the higher Shickshock Mountains and the migrants recorded on the Ste. Anne and Cascapedia rivers. Little need be added to previous consideration of the Ste. Anne (p. 80). On several mornings in late September 1947 and 1948, considerable numbers passed northward down the main stream from the direction of Lake Ste. Anne; they may have originated either in the parent valley or in its upper tributaries such as Isabelle or Castor brooks. Others descended the strong East Branch which drains a large area west and northwest of Tabletop as well as its northern slope. Reference has earlier been made to possible origin lower in the Ste. Anne Valley of those thrushes recorded ascending it in the region of its junction with the East Branch.

Under the premise that most of the migrant thrushes are of Gaspésian origin, it remains to note the increased probability that the birds observed flying westward at the foot of the escarpment south of St. Octave, as previously suggested, may now with still greater assurance be regarded as residents of the Ste. Anne watershed. This does not entirely reject the possibility that they had descended a valley farther east and had veered inland till they met the face of the Shickshocks. This escarpment may well have directed them far to the west and southwest, beyond Mts. Logan and Bayfield (Fig. 2), possibly to the wide pass over a divide at about 525 feet elevation into the Matapedia Valley. Judging from the topography south and west of Matane it seems more probable that they would have continued southwestward up the St. Lawrence.

As to movements on the Cascapedia, the stimulus of those two mornings of heavy migration, September 19 and 20, 1949, previously cited (p. 85), turns us with renewed interest to the question of the origin of these thrushes. Was it outside or within the peninsula? At Lazy Bogan where some 850 migrants were recorded in the hour preceding their descent to the ground at dawn (4:50 A.M.), the general course of the river is southeastward. The station was on the east bank midway between two curves a hundred meters apart. Fortunately in the darkness I had come to the river bank near the center of a quiet pool whence birds could be heard for some distance up and down stream.

As the birds first began piping, their course could readily be traced by ear. A number of them followed the river closely. Later migrants cut somewhat obliquely across the upper and lower bends, conveying the impression that dependence upon the river became somewhat weakened as visibility increased. Only a single thrush approached the station from a northerly direction. Possibly it was a local bird just launching itself into the stream of flight; or it may have veered westward from the Berry Mountain Brook valley that opens out rather flatly on this side.

Above Lazy Bogan the Cascapedia forks, the western Lake Branch and its tributaries draining a triangular region some 25 miles on a side. The main stream, known as the Salmon Branch or River, reaches back north-northwest an equal distance to its source in Lake Thibault, close to the northern edge of the Shickshocks. From the northeast it receives in order Brandy Brook, Indian Brook, Brook No. 17, and Brook No. 23 that drains Lake Cascapedia. These and several smaller streams have dissected the plateau west and south of Mt. Albert and the Barn Mountain region, thus providing extensive habitat for thrushes.

It appears from the map that thrushes from the Cascapedia basin north of the Berry Mountains should be funneled into the deep valley cut through them by the river, and that past the Lazy Bogan station would pass all except those from the Berry Mountain Brook area. The great numbers heard there on September 19 fulfilled expectations.

More surprising was the heavy flight down Brandy Brook recorded next morning. The first call was heard at 4:53, as on the 19th. By 5:15 they were passing at the rate of 15–20 per minute, and at 5:30, of more than 50. Thrushes began "grounding" earlier than on the previous morning; the first calls from the roadside bushes were heard at 5:34, and the last from birds in flight a moment later. More than 550 are believed to have passed on toward the Cascapedia. As calculated above, assuming a flight speed of 30 m.p.h., the earliest of these may have reached a point some miles south of the Berry Mountains before settling down at dawn.

Station 2 was within 5 miles of the divide between the Brandy Brook section of the Cascapedia drainage system and that of Isabelle Brook, a western tributary of the Ste. Anne River. This divide lies 2175 feet above sea level and directly south of Mt. Albert. Another branch of the Ste. Anne rises close by and flows eastward about the southern flank of Hogsback Mountain.

Is it likely that all these 550 thrushes were residents of that part of the Brandy Brook valley lying north of Station 2? The area is approximately 2 miles wide and 4½ miles long—9 square miles of map area, possibly 10 of ground surface over the steep, dissected slopes. Adopting 40 as the number of territories per square mile in this partially lumbered valley, a figure nearer to the 36 territories of olive-backs than to the 50 of hermits in the York Valley, and assuming that 4 birds per family survived till mid-September, there might have existed in the area (4 × 40 × 10) 1600 thrushes. Not all these would have migrated on this one morning. It must be remembered that on the previous morning many thrushes had descended the Cascapedia, as observed at Lazy Bogan. Since this station lies but 2 miles below the juncture of Brandy Brook, thrushes from this valley may well have been among them. It is unknown whether or not migrants had descended the Cascapedia prior to September 19. Few passed down Berry Mountain Brook during the evening of the 18th, but this has little significance; one needs to know what occurred on the dawn of this and previous days. We have recorded that less than a dozen thrushes passed Maria on the morning of September 21. To conclude that the 19th and 20th were the only days of strong migrations down the Cascapedia Valley would necessitate the assumption that no thrushes had left it earlier in the month. This seems illogical in view of strong movements in northeastern Gaspé during late August and the first half of September; thrushes would be expected to leave the Cascapedia Valley fully as early.

Furthermore the estimate of 4 surviving birds from each nesting territory errs, if at all, in being too large. All factors considered, then, the possibility must not be excluded that the great flight of 550 thrushes recorded descending Brandy Brook on the morning of September 19 included birds from beyond this watershed that entered through mountain passes. We have seen that thrushes ascend the Ste. Anne River toward Lake Ste. Anne. The line of least resistance—the natural avenue southward—would pass the lake into the Little Cascapedia Valley. According to Alcock (1926) the Ste. Anne, by stream piracy, has taken from the early Little Cascapedia system the region occupied by the lake. A rise of 10 feet in the water level would again spill it into that stream. In order, then, to derive, from outside the Brandy Brook area, enough birds to make up the total recorded on September 20, the plateau southwest of Mt. Albert is regarded as the most probable source. Several passes exist where streams have dissected it.

It remains to assess the possibility that all birds resident in the upper Brandy Brook area did actually depart on this one morning. Exclusion of outside migrants would require a greater resident population than the 450 calculated above. But this estimate, 450, is probably already too high. In trying to form a picture of the preliminaries to such a mass movement, I can cite only the behavior of resident hermits and olive-backs on the Sandy Beach plateau, south of Gaspé Bay. Unlike robins, no noisy flocks gathered there during the day or days preceding migration. After finishing the molt during August and September, the resident thrushes remained quietly feeding on berries, and were seen less often than heard. Then came a day when none was to be found on the square mile of plateau. All were assumed to have left during the previous night. It seems reasonable to suppose that practically all residents of similar age in a limited area should be physically and physiologically prepared to migrate at the same time. Indeed the evidence from the Sandy Beach plateau supports this possibility. On the other hand, birds collected on their territories in the York Valley as late as September 15, 1947, and September 11, 1950, were young hermits, members of the second brood. One may imagine that birds from the upper and peripheral parts of the Brandy Brook area rose from the forest before dawn and turned southward down the valley. Thrushes in succession below, if not already in flight, would be stimulated to join the pioneers; a sort of chain reaction would empty the area. One sees, however, that if the stimulus of flight notes alone were needed, not only would all the thrushes in the upper 4½-mile portion thus be set in motion, but those below as well. This would lead to a truly enormous number of thrushes that would leave the ground in succession. It is true that to a stationary listener the proportion of these that could be recorded would depend upon his position in the valley—the farther downstream, the greater the number—unless his post were beyond the point where the hindmost birds would have descended at dawn. Even the 850 recorded at Lazy Bogan on September 19 would not equal the population of the entire Brandy Brook valley. All birds in this narrow area would have been exposed to the call notes of migrants from the head of the little watershed. Under these premises the whole population—960 on the basis used above—should have moved out.

Should this formula prove to yield too high a figure, reduction of the numbers, 960 for the whole valley, and 450 for its upper portion, would be necessary. This would bring the total close to the number recorded passing down the Cascapedia at Lazy Bogan on the preceding morning. But it cannot be imagined that all those emerged from the Brandy Brook valley; for 275 square miles in the northern and western parts of the watershed doubtless contributed many migrants to the flight stream that coursed down the great river on that date.

There is evidence on the York, St. John, and Dartmouth that migration occurs over at least three weeks of August and September. Although migration is weak on some nights it is strong on others. Without recourse to departure of migrants throughout the night this population of 13,300 thrushes at the Lazy Bogan rate of 850 could be evacuated on some 15 mornings. Further study would be required to establish the size of actual daily and weekly departures. The above estimated population, as well as the number of heavy migration days required to evacuate, seem too great to agree with the records already made. But two mornings and evenings on this large river grant to the observer hardly more than an introduction to some aspects of population and migration here. Inquiry among the river men disclosed no one who could recall ever having so much as noticed the call notes of migrating birds. One phenomenon that suggests heavier movements on the Cascapedia than observed on other Gaspé streams and shores is the number of thrushes, as reported above, that passed Maria just west of the river's mouth; it was unusually great for an evening flight. If, as believed, these descended the Cascapedia, their abundance might be regarded as a measure of the greater scale upon which migration is conducted on this river, the largest in Gaspé.

Although the mountain passes leading into this watershed from the north appear to man less attractive than the much used one in which lies Lake Ste. Anne (p. 124), some of these Cascapedia migrants may have entered the valley through the passes, for example, near Lake Thibault and east of Mt. Bayfield.

MIGRATION OF THRUSHES ORIGINATING OUTSIDE OF GASPÉ

In the light of our experience with the paths followed by thrushes in Gaspé, some birds originating in the Notre Dame Mountains west of the peninsula may be expected also to descend the valleys northward to the shore of the St. Lawrence. Like those recorded at St. Octave they may well be guided southwestward by this shore, some possibly reaching the Richelieu River–Lake Champlain–Hudson River avenue that leads directly south. That other species do pass westward along this shore of the St. Lawrence has been confirmed at Cap Chat. On September 24, 1949, some 25 myrtle warblers were slowly working through trees along a steep embankment above the beach. At the edge of the beach below there was evidence that juncos, song sparrows, and white-crowned and Savannah sparrows also were drifting westward. This movement of fringillids was then generally apparent over the plateau of St. Octave d'Avenir between the coast and the mountains.

From western Quebec Labrador and northern Quebec another large contingent of hermit, gray-cheeked, and olive-backed thrushes would find a similar pathway west and southwestward along the north shore of the St. Lawrence. If they behave like the migrants that pass around the Bay of Gaspé and the Malbay, many of them may be expected to continue until a narrow section of the river is reached. On the other hand, like thrushes recorded crossing Gaspé Bay at night, the birds reaching the shore of eastern Quebec Labrador may traverse the gulf to Anticosti, the Magdalens, and Prince Edward Island, while those from Newfoundland Labrador use the Newfoundland–Cape Breton route.

Surveying the avifauna of Gaspé we conclude that from the north, in addition to shore birds, anseriforms, and other water birds, there are species that migrate into and through the Gaspé Peninsula. Included in this group are many fox sparrows, tree sparrows, longspurs, snow buntings, and probably horned larks and pipits. Although the numbers of the latter two species seen in eastern Gaspé each fall doubtless lie within the limits of the isolated population that breeds south of the St. Lawrence over the higher Shickshocks, it seems more reasonable, on first thought, to regard them chiefly as arrivals from the north. This being granted, it must be asked whether among resident species many migrant thrushes and myrtle warblers, for example, also enter from outside.

Considering first these warblers, two facts should be noted. First, the species breeds abundantly in Gaspé; second, its migration period is long, extending from as early as August 5 until October 22. Judging by the vacating of known territories, the local representatives are among the first to leave. It is believed that most of the migrants seen after September 20 enter the peninsula from outside. As yet their paths have not been fully determined. Many leave the Forillon at the Break, as well as through the West Highlands and along the bay shore. They also enter over the same routes; therefore, one cannot assume that any of them necessarily reach the Forillon by crossing the gulf from Anticosti. Nevertheless, they should do so as readily as the red-breasted nuthatches, a species that has rarely been seen entering at the base of the little peninsula (Ball, 1947).

It is certain that many of these warblers believed to have descended valleys from the Gaspé forests approach along the north shore of the Forillon. Movements have been recorded from as far west as Grande Étang. Beyond Ste. Anne des Monts the few that have been seen in autumn worked westward. It will be recalled that along the south shore of Gaspé Bay myrtle warblers not only pass southeastward but move in the opposite direction and enter the estuaries of the St. John River, and even of the York. This shore movement has been detected as far east as Chien Blanc. Possibly from the northeast across the gulf these birds nocturnally reach the coast just west of Point St. Peter, and find it easier to work northwestward by day among the birches that fringe the 50-foot cliffs than to proceed around the point to the Malbay shore (Fig. 1). For a distance of half a mile on either side of St. Peter trees are lacking for the most part; the cultivated fields extend to the brink of the cliffs. Hence this section may be less attractive to warblers than the tree-bordered shore that stretches away at a rather uniform height to the northwest—almost north in places.

We should also keep in mind that beyond the estuaries numerous myrtle warblers diurnally ascend at least the lower parts of the river valleys themselves, especially that of the St. John.

As one studies a map of the Gaspé Peninsula the causes of this northwest and then westward migration of these and other species of warblers and also of robins seems more extraordinary than the opposite radial migration down valleys that lead to the coast. The pattern bears some of the characteristics of the trial and error method. The only extrinsic stimulus yet conceived is the more intensely illuminated trees and shrubs lying to the west of birds that find themselves upon this coast between sunrise and noon.

Turning now to the thrushes, we have recorded them as abundant breeding birds in Gaspé. The number of potential migrants calculated for the York Valley in 1947 was 106,400, greater by 98 per cent than the 1775 migrants actually heard leaving this valley (p. 156). In other words, many more thrushes were raised there than were heard migrating at all observation points in the peninsula; none were required from outside areas to account for the valley migrants recorded. Nevertheless, like the myrtle warblers, the genus *Hylocichla* has a long migration season—August 18 to October 25 in Gaspé, and a wide range. There can be little doubt that some of the hermit thrushes seen on the Forillon in October came from other regions. Since both hermits and olive-backs nest commonly on Anticosti, at least a few from the western half of the island may cross the 45-mile wide strait. No direct evidence that they do so has been obtained. Although possible, it seems improbable that, with Gaspé visible, they would rise to great heights and pass over unheard.

HEIGHT AT WHICH MIGRANTS FLY

It is not difficult to imagine, but not easily proved, that, while thousands of thrushes are heard each fall migrating at low elevations through Gaspé, other hordes from the north are crossing in a higher stratum over the 70-mile width of the lower St. Lawrence and on southward above the peninsula.

A few instances of small birds flying above 5000 feet have been recorded by aviators (Meinertzhagen, 1920; McMillan, 1938). By ground observers snowy owls in great numbers were noted crossing the St. Lawrence at a "high altitude" in early November 1926 (Gross, 1927).

Such incidents as the one witnessed by Taber (Bent, 1949) on the tableland of Mt. Katahdin, Maine, at an elevation of 4300 feet in a dense fog when 24 robins flew past in a southerly direction; and migrant warblers crossing the Himalayas at 20,000 feet (Griscom, 1945), may signify nothing more than a surmounting of mountains, like our thrushes over Mt. Jacques Cartier (p. 84)—not consistent flight at high altitudes. It is known that certain migrants habitually use passes through the Alps between Italy and northern Europe (Thomson, 1926). Warblers were reported by Bagg (1950) as seen by Allen Morgan from the top of Talcott Mountain flying very high over the Connecticut Valley. These may have been carried aloft by air forced upward as the southeast wind struck the face of the mountain.

On the other hand, through the centuries myriads of passerines have been seen by day and heard by night passing at low elevations, often just above the waves (lower than a ship's deck) or along shores of seas and lakes (Thomson, 1926). At Helgoland, Rossiten, and along the Scottish coast, Gätke, the German Ornithological Society, W. Eagle-Clarke, and A. L. Thomson, to mention a few observers, have recorded low-flying migrants under optimal conditions for recognition and estimation of numbers (Brewster, 1886; Bishop, 1905; Cooke, 1915).

Lowery (1946) records important observations of many flocks of birds (warblers) heard passing southward over a ship in the Gulf of Mexico, August 24, 1945. Notes from warblers could not be heard far above the water. Lowery attributed their low flight to a cold front.

Multitudes annually migrate by day across our lowlands from 10 to 200 feet off the ground—others somewhat higher but still within recognition distance of eye and ear. Each year we see robins and bluebirds, diurnal migrants, passing in open companies not more than two or three tree-heights above the ground, closely ranked thousands of icterids not much higher, and nighthawks, true hawks, and others at similar or greater elevations.

During the early hours of the night, and especially in the pre-dawn period, common experience bears witness to the low flight of such passerines as warblers, fringillids, and thrushes. Not only open country but city parks as well afford opportunities to hear these migrants. Even above the elm-canopied streets and dooryards of New Haven thrushes may be heard year after year passing northeastward in spring and southwestward in autumn.

For the last 15 years I have recorded migrants at various hours of the night as they traverse the grounds of the New Haven Country Club in Hamden, Connecticut. As many observers can well appreciate, thrushes here, as in Gaspé, are among the easiest to identify by calls. The individuals and groups most clearly heard are those which pass overhead. Faint, distant calls come not from above but from points at the same low level on one side or another, as the birds follow lines on the right or the left. Notes of those approaching from behind the listener increase in amplitude and diminish in the distance before him. One gains the distinct impression of migrants flying not more than 300 feet above the low rolling divide (itself 50± ft. above sea level) between the Quinnipiac and Mill rivers; no voices come down from great heights.

A very convenient guide to the depth of this stratum of thrushes is the precipitous face of East Rock, less than a mile to the southward toward New Haven harbor. The summit of this familiar landmark is only 369 feet above tide level in Mill River which skirts the foot of its western talus slope. Many of these birds heard crossing the lower Country Club grounds north of it would have been obliged to rise in order to clear East Rock's summit, had they tried. As a matter of fact, few thrushes cross the Rock. As Bishop (1905) learned, most passerine migrants coming southward down the Quinnipiac Valley and from Fair Haven east of the river, prefer to pass inland around the city rather than to cross the harbor on their journey southwestward. Crossing the low ridge between the Quinnipiac and Mill rivers, these thrushes seem to follow that course; from the elevated portion of the golf course on top of this ridge northeast of the club-house the majority strike for the top of Prospect Hill in northern New Haven, a ridge of similar height. This line of flight avoids the somewhat more elevated Mill Rock.

We also have evidence as to the height of migrants in instances when they have struck obstacles such as the Washington Monument (555 ft. high) and the Empire State Building (1250 ft.) in New York. Overing (1938), reporting a total of 1468 birds that hit the former in three autumns—1935, 1936, 1937—writes (1936) that they were flying at such an altitude that their chirping was audible as they approached the monument, and that they were visible after coming within the light being projected upon it from its base. He estimated the elevation of the migrants as from 300 to 500 feet. Pough (1948) makes the interesting suggestion that birds coming south in a mass of cold air were forced downward by an overlying mass of warm air and thus reached the 1200-foot stratum penetrated by the Empire State Building.

Spofford (1949) describes a remarkable instance of birds "falling down the beam" of the ceilometer, a powerful mercury-vapor lamp at the Nashville Airport in Tennessee. The beam was capable of illuminating clouds at 15,000 feet, but the observer estimated that birds were distinguishable at elevations of 500 to 1000 feet. The cloud level was above 5000 feet.

Numerous records of the striking of lighthouses have been published. In many of these cases an element of uncertainty enters; the reaction of the birds is only partly known. They may or may not have descended from a higher level, or risen from below, attracted by the light source.

As Williams (1950) has written, for meteorological reasons alone birds are likely to avoid flight at high levels.

One might conceive of nocturnally migrating thrushes flying at an elevation of 5000 to 10,000 feet in a rather direct southerly course, uninfluenced by bays and river valleys. As dawn approaches they might drop to lower levels preparatory to feeding. Supporting this supposition is the fact that few thrush calls have been heard during the middle hours of the night, and that many have been recorded just before dawn. Opposed to it is the ease with which the relatively few midnight calls are heard, and the uniform level at which the thrushes uttering them are flying. There is no evidence that birds are then approaching the earth from higher levels, nor have vigils on top of the highest elevations of eastern Gaspé, between 1000 and 2000 feet, and on Mt. Jacques Cartier (4160 ft.) in the west, disclosed thrushes crossing high above mountains and valleys.

Early observations made through telescopes directed at the moon are difficult to evaluate as to the height of the birds above the earth, for much depends upon the judgment of the observer. More recently, however, several studies in which two telescopes were used simultaneously have yielded more trustworthy results. Using this method over the low terrain of Louisiana, W. A. Rense (1946), calculated an average height of 2200 feet above the ground for passerine migrants crossing the moon May 20, 1945. The sky was clear, the wind northwest 5 m.p.h. This velocity assumed to have been at the ground surface, suggests that these birds were migrating under optimum conditions, and at greater than average height. It certainly far exceeds that of Gaspé migrants thus far encountered.

After learning from Rense (1946) his refinement of Carpenter's method of telescopic recording of migrants crossing the moon's face, Lowery (1946, 1951) thus observed birds flying northward at Baton Rouge, Louisiana, and over Yucatan's northern coast at Progreso. Through the coöperation of many observers he extended these studies over much of eastern United States, and to Tampico, Mexico. Lowery placed the upper range of flights at somewhat under 4000 feet. On page 55 previous reference to Lowery's important research is made. These two papers add incontrovertible evidence to previous claims that under some conditions of time and place migration proceeds at heights beyond unaided vision and audibility.

On the basis of present data one cannot deny that high above Gaspé migrants sweep on southward. But little evidence is available that the thousands of thrushes heard migrating there within a few hundred feet of the ground were derived from such a height. On the contrary many facts support the belief expressed in this paper that these birds are chiefly residents of the peninsula setting out on the initial stage of their southward flight. In relatively few instances of large flights were cold fronts with their associated phenomena so located, either before or afterward, as to bring down thrushes over Gaspé (p. 102).

In Gaspé many night vigils on hilltops from 1000 to 2000 feet in elevation have yielded no records of birds passing overhead. The calls of migrants come from the slopes and valleys below. Some of this evidence has already been presented.

Similarly, studies in the New Richmond area in 1951 showed that before dawn thrushes leave the Little Cascapedia by rising to surmount the divide instead of descending from high above, and gave every evidence of making sustained migratory progress with no intention of descending to the ground within the next few moments.

There is a high pass in the highlands embraced in the northerly loop of the York River. On its summit lie two small lakes from which Tom's Brook drains west-southwest into the York. Another stream, arising east of the lakes, flows northeastward down to the main river. Observations were made here in coniferous forest about the lakes (Station 1) on September 14, 1950. Only a single thrush was heard here. At 4:57 (light intensity 0.002 f.c.) it passed eastward, about 300 feet above ground. It should further be emphasized that, judged by the sequence of its notes, the bird certainly was using the easterly "short-cut" pass over the mountain. In all probability the bird had ascended Tom's Brook, rising more than 650 feet in 4 miles. In other words, it had not approached at the level of the mountain tops near by on the west and north. The highest elevation there is about 2050 feet. The very fact that its flight was not southward but even somewhat north of eastward renders its behavior consistent with that of all migrant thrushes recorded in Gaspé; apparently it was following a valley, not a southward course high above the terrain. Other instances of thrushes found ascending valleys have been recorded earlier in this paper (e.g. Ste. Anne and Fox rivers, p. 80).

Occasionally, as recorded on Mt. Jacques Cartier (p. 84), one is heard barely clearing a mountaintop, but none high above.

The very fact that migration is radial from the higher mountain masses bespeaks the local rather than distant origin of these thrushes. Downstream migration is so general at all parts of such a valley as the York that descent just before dawn from high-level flight seems unlikely. Even were one to concede that far up tributaries the few birds heard near the summits of the mountains had done so, those which had simultaneously accumulated near the mouth of the river could not have had time to descend from the upper watershed unless their descent had occurred hours earlier. There certainly is no evidence for their sudden immediate descent from overhead; abundant calls confirm the consistent down-valley flight. If migrants were flying southward, say at an elevation greater than 1000 feet above the mountains (3000^+ above sea level), and were to be attracted downward at dawn by a mass somewhat higher than the rest, would they not all pass to the southern slope and reject the northern valleys? A southward "urge" would favor such behavior. One must grant, however, that as soon as thrushes closely approached the ground, topography, including horizons, would exert its influence. A bird that dropped within the upper end of a valley, would according to our observations, descend it in whatever direction it trended until a southward outlet was attained.

Furthermore, evening migrations also follow this course. For example, those thrushes heard leaving the ground at Madeleine Fork, as stated above, rose but little above the trees before leveling off downstream. Not much farther above ground have been the birds heard on several other evenings descending the York. For example, on August 24, 1950, near Silver Brook, about 5 miles above the head of the York estuary, more than 25 thrushes passed eastward during a 3-minute listening period. Judging from the calls these birds were flying in small groups parallel with the York River, but on a course at least 300 to 500 feet north of it at the foot of the mountain. They were just above the tops of the forest trees that covered the nearly flat river-bottom. The weather was fair.

Similarly, on September 7, 1948, also fair, the first 5 thrushes were heard after darkness had fallen (7:50 P.M.) flying low down the York Valley near 28-Mile Brook. At every subsequent stop the flight was evident; 12 at 8:20, 10 at 8:40, 6 at 9:00, 3 at 9:15, and 7 at 9:30, the last at the upper end of the estuary. The fact that none was detected below this point may have been due to the shifting of the flight-line across the divide into the St. John Valley.

Low evening flight of thrushes in fine weather has also been recorded several times at Sandy Beach. These birds were following the bay shore eastward and were regarded as migrants that had left the ground during the evening, and had descended some valley, or followed the coast. It is important to note that in all these cases the birds remained within 150 feet of the ground, whereas if high-level flight were to have been adopted, they should have already ascended and turned southward.

In early September, 1950, 12 thrushes were recorded at early dawn crossing the summit of Mt. Jacques Cartier (4160 ft.) the highest elevation on the Tabletop Mountains in the Shickshocks (p. 84). In several small groups they passed in a southerly direction. Why should one not assume that they were members of a stratum of migrants flying at a level of 4000 feet or higher? Four reasons may be given. First, as explained above, some of the birds behaved as though ascending the slope in order to surmount the summit. With relation to light intensity, their time of appearance there was several minutes later than average for thrushes descending to the ground. This may be interpreted to mean that, rather than being members of a high-flying layer, they had been ascending the northerly trending valleys. Secondly, very few were recorded at this elevation, in contrast to the large numbers, 27 to 713, counted daily in the lowlands since August 21, and also subsequently to September 8. Thirdly, some of the migrants heard on Mt. Jacques Cartier were flying southeast by south, whereas the majority passed south or south-southwest; this lack of uniformity seems inconsistent with the idea of birds freely migrating directly southward high above the earth. Fourthly, experience had already shown very few migrants at heights above 2000 feet (p. 168). Of the thousands recorded in the Gaspé Peninsula since 1935, practically all have been flying below 1500 feet above sea level, the great majority under 500 feet.

Origin of migrants within tributary valleys of local rivers, rather than from afar at high levels, is also suggested by weaker movements in such valleys as lack good passes at their heads. For example, Whitehouse Brook and Fall Brook flowing southward into the York are similar in size but on the former many more thrushes have been recorded. A large proportion of these apparently approach through the pass that lies west and south of

Mt. King. Some of them, as stated elsewhere, are believed to come from the Madeleine watershed. On the other hand, Fall Brook descends steeply from mountains that separate it effectively from the Dartmouth headwaters on the north. Again, Mississippi Brook, next tributary to the east, connects with the Dartmouth by two high passes, and also exceeds Fall Brook in numbers of migrant thrushes. It remains to confirm the assumption that thrushes, robins, and other birds migrate southward up the Dartmouth as they have been observed to do on the York between Whitehouse and Caribou brooks. From its origin in Dartmouth Lake, the Dartmouth River flows northward for 14 miles before turning sharply eastward (Figs. 2, 3).

Assuming for the purpose of discussion that migrants on a broad front sweep southward high above Gaspé by night, and possibly by day, how shall we regard the valley and coastwise migrants observed each year? Have they 1) descended from the high-flying group, or 2) are they local residents setting out on the first step of their journey, or 3) have some of them followed the coast for long distances or ascended valleys from the north shore of the peninsula and crossed divides only to descend, for example, the York River where they were observed?

In attempting to answer the first question it must be conceded that nocturnal migrants 2000 to 5000 feet above the earth, under various intensities of twilight, starlight, moonlight, and frequent Aurora Borealis, added to the so-called "permanent Aurora," are doubtless able to discern the coastal outlines. Possibly large streams and valleys, as well as the chief mountain masses, may also be visible. Some of the birds, attracted by these features, may conceivably descend below the 1500-foot level, thus becoming audible to the listener on the ground.

Restricting ourselves to the early morning period we may regard the individuals that have been traveling throughout the night as the hungriest and most fatigued, and hence most likely to be attracted earthward as topographic features became visible. From aloft they would sense the earliest dawn light. In succession, descent would be made by thrushes in order of arrival over a given area—say the Gaspé Bay region.

The last to stop flight, as the deadline of 0.02 f.c. intensity is reached, require further consideration. They may be regarded as strong birds that have been able to make the longest flight of all, both in time and in distance southward. Or, on the other hand, they may have started late, even as dawn twilight first became sensible (p. 68), and so have flown only a few miles; for if a certain light intensity *per se* should prove to be the releaser that sets the birds in motion, both evening and dawn twilight should be effective.

This intensity may vary within a family of birds. Thus the robin, *Turdus m. migratorius*, a close relative of the true thrushes, is chiefly a diurnal migrant that often begins flight shortly before sunrise. The light intensity then is not only greater than that under which olive-backs and hermit thrushes drop to the ground but even greater than the intensity that, according to our hypothesis, stimulates members of the genus *Hylocichla* to begin the flight in evening twilight. However, a psychological factor may enter here; the robin "anticipates" increasing intensity, the thrush, a decrease.

This conception of migrants leaving their territories at dawn may be developed about the possibility that not all migrant thrushes descend to feed at dawn. Other species such as warblers, usually considered to be nocturnal migrants, have been reported traveling by day. For instance, Van Tyne and Trautman (Wilson Bull. 57:204, 1945) while stationed at Progreso on the northern Yucatan coast in the spring of 1936, saw small birds which they believed to have been warblers flying northward across the beach *throughout each day,* and continuing over the ocean. These circumstances suggested that the birds were migrants; nocturnal observations by Lowery (1946, 1951) confirm this (p. 168). Gätke, Eagle-Clarke, Thomson, and others in the British Isles and Europe (Helgoland and Rossiten) have pictured the diurnal arrival and departure of many species. Brewster (1886) at Point Lepreaux, New Brunswick, on the Bay of Fundy, saw myrtle and redpoll warblers make landfalls and again put to sea "at various hours, but usually in the early forenoon." Their number, however, was small compared with that of nocturnal migrants recorded at the lighthouse. Numerous articles record diurnal movements of species that are regarded chiefly as nocturnal in the migratory flights. Spectacular are those witnessed at Point Pelee and Cedar Point (Lynds Jones, 1906, 1909; Gunn and Crocker, 1951), which face each other across Lake Ontario; and about Cape May at the mouth of Chesapeake Bay. Other instances will occur to the reader.

One may therefore entertain the possibility that, while others are descending to feed at dawn, those thrushes heard still in flight, until beyond ear-shot, continue for some distance. However, evidence obtained both in Gaspé and Connecticut renders this view unacceptable. Since 1935 the behavior of thrushes has been studied on scores of mornings during spring and fall. Without exception the calls of birds *in flight* have ceased by the time the light intensity has reached 0.10 f.c. This is not to say that similar notes are not occasionally uttered from the ground (cf. p. 50). Olive-backs, especially, are prone to continue the clear flight notes for a few moments after alighting on the ground, in trees, or in shrubs. There is little difficulty in deciding that these birds have finished their flight; the notes, if repeated, maintain the same degree of loudness, and issue from the same locations. Furthermore, the position of ground calls that usually ensue confirm this judgment. Not infrequently one sees the birds darting excitedly about in the dim light. On several occasions they have barely missed collision with the observer. Then follows the feeding period, during which, vocally, the thrushes are silent; but the snapping of bills and fluttering of wings among the branches and ferns still serve to locate the near-by individuals. This may continue for 10 to 30 minutes in the case of olive-backs. Then some of them utter a ground note or two. Such notes establish the position of birds too distant for the detection of sounds made in the procuring of food. Hermit thrushes, when coming to earth, are more likely to cease their flight calls immediately and to utter the *chuk*, so characteristic of this species.

Is there factual evidence that suggests what becomes of those thrushes that pass beyond the area within which their calls are audible to the observer during the brief period when others are dropping down near him? Soon after dawn on these mornings thrushes have been discovered occupying suitable environment in the line of flight. The fact that these niches had been devoid of thrushes the previous day supports the conclusion that at least most of these birds were indeed among those heard overhead at dawn. Such evidence must, of course, be used with caution, for thrushes are notoriously difficult to find in dense cover. Therefore a few may have spent the night here.

The consistency of their behavior lends confidence to the belief that no thrushes fly far after the dawn light reaches 0.02 f.c. On every morning when these birds are migrating a large proportion of the latest ones audible to the observer come infallibly to the ground during the usual brief period. Never, in these years of observation, has any evidence of descent *after* dawn been obtained; no thrushes have been seen or heard on or near the ground during the day in circumstances that indicated more than that they were either residents still on home territory, or that as migrants they had previously entered the area.

Furthermore, though the sky has frequently been scanned after a strong dawn movement, not a single thrush has been detected above the level of mature trees; in other words, all individuals observed in the forest and about the "burns" were engaged in diurnal activities connected with feeding and resting. Were any still in migratory flight after dawn they should, unless high in the air, be as easily seen and heard as their close relatives, the robins.

One may reasonably ask, if some thrushes descend at dawn as amply proved, why should not similar behavior be shown by all migrants on a given morning? It is believed that they do so, even though it is undetectable later in the day. It is true that other nocturnally migrant species have been seen continuing their flight long after dawn, or have been observed under conditions suggesting that they must have done so. For example, Lowery (1946) states that passerines cross the Gulf of Mexico and even the coastal strip of the Gulf States, necessarily flying a considerable part of this 500 miles by daylight. Especially at times when a cold front advancing from the north under-runs the prevailing warm, humid air mass over the gulf, or its coast, thousands of migrant land birds are precipitated upon islands and the neighboring shore. The migrants through the Gaspé region, however, encounter no such expanse of water as the Gulf of Mexico presents. Even the broad, lower part of the St. Lawrence is less than 75 miles wide.

In answer to questions 1 and 2 on page 171 we find, then, no necessity for assuming flight at high altitude by these thrushes.

As yet no serious attempt has been made in Gaspé to detect birds crossing the moon's face. Little success has rewarded an occasional brief evening or morning period of observation with 7-power binoculars; the few individuals that swiftly crossed the disk were judged to be not more than 200 feet above ground. Nor did a 3-inch telescope, available on a few evenings and mornings in 1948 (Sept. 16, 17, 20), disclose any migrants. There certainly were no such numbers flying in Gaspé as were found by Rense (1946) in Louisiana, Carpenter (1906) in Rhode Island, and earlier observers.

Our belief that the valley migrants are Gaspé residents rather than birds from the north that have dropped down from high-altitude flight, is strengthened by the following considerations. In attempting to find the source of the streams of migrant thrushes that pass eastward along the bay shore at Sandy Beach we have found at least four contributing lines of flight, 1) the York River valley, 2) the Dartmouth Valley, 3) the Fox River portage, 4) the north shore of the peninsula by way of the Forillon. All but the first of these lines converge at the upper end of the Dartmouth's estuary and thence follow the south shore, cross the mouth of the York from Cape O'Hara to Lobster Point, and continue eastward.

Significantly, the heaviest flights descend the rivers that enter Gaspé Bay. Many hundreds each year—more than 700 on a single morning—have been recorded there. On the other hand the number (possibly from beyond Gaspé) entering the Forillon from the north shore at the Break, or passing Grande Grève in either direction, seems never to exceed 50. Those from the mountains about the Fox River pass and the comparatively small stream leading to Gaspé Bay give every indication of being local residents. The fact that their numbers have not exceeded 100 on any one morning supports the assumption that, in contrast, the great numbers found descending the near-by Dartmouth have accumulated from the various tributaries of this large river.

The relatively small numbers of migrants recorded entering the Forillon at the Break and northern end of the Grande Grève portage indicate a weak movement southeastward along the north shore at low altitudes within audible range of their call notes. They may have originated in any one of the small valleys between Cap des Rosiers and Chloridorme, or even farther west. Again, in small numbers, they may have crossed from Anticosti. Therefore the only source, alternative to local territories, attributable to the abundant majority of valley migrants is descent from a stratum of thrushes from the north or west flying above the peninsula at high altitudes. The direction pursued by these birds while aloft might either, as usually assumed, be to the south; or easterly above the north shore and its "hinterland," doubtless visible except on the darkest nights.

If the birds drop down from above to follow the valleys they must do so before the ground illumination has begun to intensify or very soon afterward (0.0001 to 0.0005 f.c.). They would then enter the zone at which the descending horizon exerts its influence, thus directing them radially down the valleys that lead from the highlands toward the river and Gulf of St.

Lawrence, and Chaleur Bay. In other words, we may picture a stratum of migrants passing southward high above the earth. As the morning twilight outlines more clearly the coast and peninsula some of the birds, probably those that have flown the farthest, descend. But upon approaching the earth, visibility is found still insufficient to discern attractive grounding places. Therefore the thrushes must remain in flight down the valleys and along the coast until the twilight intensity has reached about 0.0025 f.c.

The flaw in this picture is that, at this time, the great majority of the birds are recorded descending the valleys; comparatively few are heard along the shore. One would expect the latter to be more attractive than mountains at the time the assumed high stratum is forsaken. Furthermore, why should birds descending from high above the earth turn down valleys to reach the shore instead of southward above the terrain? Were any birds from this high stratum to drop into a distant part of a valley early enough to permit attainment of the coast, the time would necessarily be two hours before dawn, and visibility very low over the forest.

In relation to possible high altitude flight of thrushes how shall we regard those heard at various times during the evening twilight and early hours of night? First, we have recorded them at dusk, leaving the ground and flying down valleys or across a plateau without rising more than 200 feet within the half-mile in which their calls were still audible. Secondly, many observers have reported hearing them in the evening, some flights continuing well into, or even throughout the night. At Maria, as recorded elsewhere in this paper, hundreds of thrushes coursed along the flat lands of Gaspé's southern shore. The first were heard at 7:50 P.M., the last at 9:15. The important characteristic in this, as well as the other flights, is that the calls were readily heard throughout the period. In other words, the last thrushes were flying at no greater altitude than the first ones; they had not ascended beyond audibility. The impression was very strong that a huge group of thrushes had passed, the leaders widely spaced, the main body well concentrated, and the rear guard again decreasing in numbers until the last were separated by many seconds in time, but like their predecessors, flying steadily not more than 300 feet above the earth.

Were these birds restricted to lower elevations by meteorological conditions different from those of evenings when few or no calls were heard? At the ground surface the temperature was warm and the winds from 7 to 9 m.p.h. as on the two preceding evenings when no movements down the Cascapedia occurred. Light intensity was somewhat higher owing to the first breaks in the cloud layer that had covered the region. From 2000 to 5000 feet above the earth the wind (S to NW) was similar in strength on these three days—12 to 14 m.p.h., while at 10,000 feet it was westerly, 26 m.p.h. on the 20th, 24 on the 19th, and higher (42) on the 18th. We find in these data no reason to believe that meteorological conditions aloft caused this unusual evening flight at Maria on the 20th.

These observations may be used in support of the high-flight hypothesis by remarking that the early evening migrants could with greater ease still perceive terrestrial features—in the instance of Maria, the outlines of the coast. Therefore they had felt no compulsion to rise. But the cogency of this argument is reduced by the fact that the light intensity at 9:00 P.M., while the flight still continued, was about as low as at any time during the night. Yet the issue is blurred by the thought that at this moment the majority of call notes in the audible zone had already been recorded. One may of course, reason that many others were still passing, having ascended above this zone, but my picture as drawn above is rather of a great low-flying group of which the latest thrushes heard were the rear stragglers—birds that had left the Cascapedia Valley (p. 86) either later than the main body of migrants, or from areas farther up the valley.

In considering the visibility of topographical features to a nocturnal migrant we must remember that observations of birds crossing the moon's face, reputedly at high altitudes above the ground, usually have been made when the moon was nearly full (third quarter). Since the earth is most fully illuminated at this time it seems unlikely that birds are forced to migrate at high altitudes by inability to see the terrain. Other factors must be operating. At any rate we hesitate to use visibility in support, or denial of the high flight of thrushes above the Gaspé Peninsula.

However, we may cite here one instance of poor visibility in which descent through a heavy cloud layer seems very improbable. At dawn September, 1950, rain was falling in the York Valley, but thrushes were passing down it in the Mississippi Brook area; there can be little doubt that they had been flying near the ground.

With a view to clarifying the picture of thrushes alighting at dawn we may now ask three questions: Do they

1. drop all the way from a high level in one decline?
2. drop from 5000 feet to 200 feet, then fly some distance before alighting at a chosen place?
3. descend from a moderate flying level above which they have never ascended?

Number 1 almost certainly must receive a negative answer; all data now at hand so indicate. Observations made from single stations can be used in support of positive answers to both Number 2 and Number 3, for groups flying within audible distance of the earth may have reached that height by either method. But observations from a succession of stations, as along the road for 6 miles from Whitehouse to Madeleine Fork (p. 75), strongly suggest that the same birds are being traced at an even height not far above the ground. This was confirmed by following a single group by automobile, like the flight recounted above kept within audible range for a distance of 5 miles from Wakeham, near the upper end of the York estuary, into L'Anse aux Cousins portage behind Gaspé (p. 74). For an equal distance on a third occasion (p. 73), along the south shore of the Dartmouth estuary from Point Navarre to Cape O'Hara, an excellent hard-surfaced road enabled me not only to hear the thrushes but to determine by the speedometer that they were flying at the rate of 32 m.p.h. They traveled the 5 miles in 9 minutes and 22 seconds and were continuing at the same height and rate when last heard as they struck out across the harbor's mouth for Lobster Point on their way down the bay. Furthermore there was every indication that they had already flown similarly for some time before they were first heard at Point Navarre.

This is not the behavior to be expected of birds that had descended from a great height, attracted by the earth now becoming clearly visible below them. Therefore question Number 2 above can be given a negative answer, leaving the 3d alternative more firmly established as the true one.

CONCLUSIONS

Inspection of a map suggests that in autumn birds from northern Quebec would easily cross the 70-mile width of the St. Lawrence Gulf to the Gaspé Peninsula. Some might stop at Anticosti Island, 45 miles distant, to be joined there by local summer residents. Others might be expected to cross the river at Pointe des Monts, a flight of 40 miles, and strike southeastward into Gaspé; still others from the region west of the Matapedia River. In passing through Gaspé three methods are possible. First, crossing from the north at high levels; second, flying along the coasts at altitudes within range of the human ear and eye; third, flying through passes and over divides leading southward across the peninsula.

For migration into the Gaspé Peninsula from the north little direct evidence of birds actually in flight or alighting near the shores has been obtained. But the appearance each fall of species not known to nest there (p. 27), at least in numbers sufficient to account for the migrants recorded, assures us that entry from the north, or the northeast, does occur. The natural inference is that they have crossed the St. Lawrence River or Gulf in a stratum of air at too great an altitude to be noticed or heard, and that, when over the peninsula, some of them have descended to within audible range in their search for a landing place. Such birds as the latter might also be regarded as having changed at dawn from a reaction to stimuli reaching them from major land masses and bodies of water, to reactions from mountains, river valleys, and coastlines as these become more clearly visible with increasing light intensity. This is possible, for evidence from various authors cited in this paper leaves no doubt that, under certain conditions, birds do fly, or "ride," in air strata exceeding 1500 feet above the earth. This, as long experience in Gaspé and Connecticut has established for the author's ear, is near the upper limit of height below which migrant thrushes can be heard when no other sounds interfere (p. 49 and Appendix, p. 197).

Other data, however, leave no less doubt that passerines as well as representatives of lower orders, in fair, as well as cloudy, weather cross large bodies of water within a few feet of the surface. They have been seen diurnally from vessels and many have come aboard them—some reports omitting meteorological conditions and the time of day or night. Similarly, over land, small migrants are frequently heard or seen in flight at altitudes below 1500 feet. In open country some pass less than 50 feet from the ground (p. 167). The great majority of Gaspé thrushes fly not far above the treetops—100 to 500 feet (p. 169). Voices, when faint, are heard in horizontal distance, not vertically. This low altitude is true not only along the shores, but in the valleys.

Well over 50 per cent of several seasons' total, exceeding 45,000 migrants, have been recorded passing down the valleys of rivers and their tributaries. Most of the others were following the shores of Gaspé and Chaleur bays, which they had presumably reached from the interior of the peninsula after descending the valleys. Less than 10 per cent, either at dawn, or later, ascended valleys toward the highlands. Most of these are believed to have found passes through the mountains. Although relatively few actually have been recorded doing so, this probably is due in the main to the comparatively restricted opportunities for observation. Those noted along Caribou Brook and at the St. John–Grand River divide are very suggestive (p. 157).

The birds heard thus in migration toward the coasts were chiefly—hermit, olive-back, and Bicknell's thrushes, species known to breed in the interior of the Gaspé Peninsula. They are believed to have been local residents departing for the south, not migrants from beyond the peninsula that had just descended from high-level flight. The chief evidence of this local origin lies in the various directions followed in leaving the central highlands. Not only do thrushes, warblers, and fringillids descend southward-trending valleys, but other valleys whose rivers flow southeast, east, northeast, and even northwest and north (pp. 79, 80, 90). In other words, there is a radial migration from the high central mountains.

An attempt to derive these valley migrants from a high stratum of birds crossing southward above the peninsula seems unreasonable (p. 174). Such birds, in their flight toward a southern goal, would be unlikely to change this course to others so diverse as those listed above.

Any supposition that they dropped successively into a given valley at different points so as to appear most numerous near the mouth involves two alternatives: 1) More birds descend to the mouth from on high during the critical period of light intensity (0.02 f.c.), or 2) They drop down earlier and farther upstream, if near its source, when darkness prevails. Under such low visibility, descent from above, far from the coast, seems less probable than departure from the ground by residents or resting transients to whom at least the horizon would even at this early hour be visible.

That we are dealing with thrushes of Gaspé origin is further indicated by the increasing numbers observed at stations successively farther down the valleys. Each tributary contributes its quota, and this is true along northward- as well as southward-flowing streams that enter the York and St. John rivers. And finally, thrushes on a few occasions were recorded leaving the ground under circumstances that strongly suggested the beginning of migration from summer territories. In the majority of these instances the birds without hesitation launched themselves downstream.

That departure of some thrushes occurs not long before dawn has been established by a few fortunate observations. One may justifiably infer that these are not exceptional, for such opportunities to witness them must obviously be rare. Since birds were recorded leaving territories at both ends of the York Valley, as well as its central region (p. 94), we may infer also that the majority of migrants recorded in such valleys have been residents of it. Therefore, the fact that migrants are heard throughout the valley length at dawn suggests that some of those recorded near the mouth started earlier from areas far up the river; greater numbers in the lower valley indicated an accumulation there of thrushes that started at different times from other parts of the system. This down-river increase in numbers was confirmed by rapid automobile traverses on different mornings, both up and down the York Valley (p. 74).

The fact that thrushes migrate down small headwater valleys at dawn can be used to support either distant or local origin. On the one hand, based on the usual conception that birds begin their journey in the evening and fly all night, the large movements observed on Brandy Brook (pp. 86, 161) in the upper Cascapedia Valley and at Whitehouse Brook on the York (p. 75) are explainable as having originated far to the north. On the other hand, my observations of thrushes departing throughout the night also offer a logical explanation of migration by local residents at any point in a river system. Greater numbers generally observed in the lower parts of valleys favor local origin through accretion, from the middle and lower valley, to the ranks that started earlier from the upper parts of the watershed. The large flights recorded far up Brandy and Whitehouse brooks were exceptional, the latter doubtless deriving migrants through a pass from the Madeleine Valley.

As interpreted above, the remarkable evening migration of thrushes witnessed at Maria (p. 87) on the north shore of Chaleur Bay consisted of birds that had been recorded far up the Cascapedia at dawn of the same day; they had resumed flight from the lower reaches of the river, the earlier individuals from near the mouth, the last (9:00 P.M.) possibly, though not necessarily, from the very headwaters near Lake Cascapedia. But thrushes rising still farther away could not have reached Maria until later than 10:30. Since on this evening none were heard later than 9:10, nor in considerable numbers on any evening after 10:00, nor before 3:30 A.M., if large groups pass during this midnight interval their members must fly silently. This conclusion applies as well to great morning movements; not until three-quarters of an hour before dawn are many call notes audible. However, long experience having shown that large flights at dawn are exceptional in the upper parts of valleys, we conclude that as a rule the major movements comprise birds that have accumulated from within a river system.

Stimuli to which migrants react lie in two categories; those which cause the birds to leave their territories, and those which direct them upon their way. Concerning the former, degree of temperature has been shown to be unacceptable as the starting stimulus (p. 96); thrushes in Gaspé as often migrate in warm weather as cool. In 1947 and 1950 first flights passed on very warm mornings, while cool temperatures were recorded in 1948 and 1949 (Table 3). Similar variation holds true for the average temperatures over the several annual periods from August 16 to the date when the first migratory movement occurred. While certain data may be used to support the concept that temperature change is a stimulus to migration, other instances render it unsafe. That sudden change of temperature is not always the inciting stimulus is suggested by observed instances in Gaspé. On some of them, at periods when migration might have been expected, change of temperature was apparently associated with migration; in other instances it was not.

In his review of the literature concerning the annual stimulus for migration Farner (1950) finds the data suggesting "that *Zugunruhe* is the expression of fundamental physiologic factors although environmental factors may have important stimulating, inhibiting, or modifying roles." One may agree with his further statement that migration results from "the release of a complex inherited behavior pattern stereotyped in the nervous and endocrine systems."

It must be admitted that, given a thrush in the disposition to migrate, the actual stimulus that sets the bird in motion southward is unknown. It may prove to be any one, or a combination, of several releasers, and not the same on all occasions.

We have discarded the conception that reduced volume of food is in Gaspé a prime stimulus to migratory restlessness (p. 92). Shortening of daylight periods necessary for food procurement is a more probable factor. Such nonconformities (or lack of correlation) of migration flights with meteorological conditions as have been cited (p. 97) may rather be explained by changing periods of illumination.

An analysis of meteorological conditions pertaining to the four instances (p. 67) in which thrushes were heard departing on migratory flights was made in an attempt to discover the immediate stimuli that set them in motion (p. 68). Neither temperature, surface winds, nor degree of light intensity proved helpful. Only partial correlation of good flights with low atmospheric pressure appeared possible in a few instances.

Some evidence was obtained (p. 111) that earlier nesting seasons, as in other species and regions, are followed by earlier first movements and earlier departure of the majority of the local population. So much for stimuli initiating migration.

Concerning directive stimuli, we considered first those that might determine the course taken by a thrush in leaving the ground. The conclusion was reached that meteorological factors could not be responsible; for at a given moment before dawn birds were passing down valleys radiating in many directions from the central mountains. For this same reason the efficacy of the greater intensity of dawn light in the east was discounted.

One possible visual stimulus acting upon birds leaving their valley territories is the descending horizon line (p. 122). Its general trend from the mountains to the coast is obvious. Exceptional instances of indecision on the part of migrants leaving tributary valleys, and of occasional diversion up-valley instead of down (p. 132) were found explicable by unusual topographic features peculiar to these localities; the exceptions thus tended to prove the rule.

Divides, associated with passes through the mountains, constitute a similar but somewhat special testing ground for the horizon hypothesis. At the summits of well defined divides of limited extent, e.g., at the origin of Fox River and Mosher's Brook (Fig. 10) thrushes passed simultaneously northeast down the former and southward down the latter. Furthermore, the loose stream of migrants was recorded splitting dichotomously at the divide. Similar and even more striking behavior was exhibited at the mouth of the divide between the watershed of Second Fork, a northeasterly flowing tributary of the St. John River, and the drainage into the southward-flowing Grand River (Fig. 26). The divide was undetectable to man; to the flying thrushes the horizon was doubtless the decisive factor. But, whatever the stimulus, it failed to influence all the migrants alike. Those that turned down Second Fork may have had a different traditional history. Or again they merely reacted differently where a multiple choice was presented. Finally, although an appeal to tradition and "racial memory" may lead to the conclusion that two groups of thrushes with somewhat different history had joined and then separated in this flight, one may perhaps detect here a lapse into random wandering on the part of one or both groups in seeking a southern avenue. The same may be said of other flights where the currents divided, e.g., a splitting off of thrushes from the main movement along the southern shore of Gaspé Bay to ascend estuaries, and again of birds that descended the St. John estuary's north bank, some turning east and others westward at Cape Haldimand, also flights in two directions from the Whitehouse bend on the York River (p. 75).

Observations thus far made at Lake Ste. Anne, which lies in a relatively long pass, and only 10 feet below an almost imperceptible divide (p. 124), emphasize the importance of the horizon (sky) line. Migration northward here by birds from the north end of the 2½-mile long lake, and southward from the south end certainly cast doubt upon their dependence solely on ability to orient toward a southern goal. No evidence was obtained that meteorological factors (especially wind) were decisive. Again, in order to account for the paths taken by these migrants, we are constrained at least temporarily to rely upon instinct and tradition (Farner, 1950; Marshall, 1951; and others). That the reactions involved are released by environmental factors, working with an internal rhythm, may be safely concluded.

As to stimuli acting upon a bird during its journey, these same sloping horizon lines on each side of a valley are believed to be effective. So far from the rivers do some birds fly that the stream itself seems unlikely to serve as a continuous guide. Once under way in a given direction, a bird's inertia may help to prevent deflection. However, in the York Valley instances were described of thrushes changing their course as though attracted by the increased intensity of dawn light in the eastern sky. This may also have been true of thrushes descending the Ste. Anne River. Some of those following the westward-flowing part of the river swung northward over the hills toward the coast and the brightening eastern sky. But, judging from other observations of westward migration along this coast, these thrushes upon reaching the shore a few minutes later, presumably turned southwestward away from the eastern light. Unmistakable evidence was obtained that warblers and robins, after sunrise, were attracted to sunlit hillsides, and even to brilliantly illuminated individual trees, thus at times altering their course considerably.

Atmospheric pressure, *per se,* is rejected as a directive of migration. Scanty evidence indicating the drift of hawks by wind was obtained, but numerous important incidents threw doubt upon its efficacy. Without difficulty nearly all flew against it during their return westward up the Forillon.

The remarkably radial character of migration by thrushes from Gaspé highlands is believed to result from their tendency to descend valleys. But inheritance may be at least partly responsible. Tracing the probable evolution of these paths leads to the conviction that, after the withdrawal of the Laurentian ice sheet and the ice caps from the higher Shickshocks some 25,000 years ago, the birds entered Gaspé along the coastal lowlands, and thence penetrated the valleys. Autumn descent naturally followed. Thus through annual repetition the valley paths became established, and in a sense traditional through leadership by older individuals (Brewster, 1883).

Orientation toward the south is by no means exhibited by all Gaspé migrants as they depart upon the long journey toward their winter range. It appears that orientation is made not toward a particular point of the compass, but rather, on the part of adults, toward topographical features recognized and remembered from previous experience. Random wandering in search of coastal routes southward seems to find no application here by the majority of thrushes; for only a minute proportion of them have been recorded setting out in any direction except down the valleys from which they arise.

Four instances of departure by thrushes on migratory flight from Gaspé have been described (p. 67). While it is gratifying to have witnessed even so few, the number of hours spent in the field has left the author with a feeling of disappointment that he was unable to acquire more such data. Considering merely the years 1947–1950, 98 flights comprising at least 12,800 thrushes were heard in the course of some 450 periods in the field. Of these periods 250 were pre-dawn to dawn, 150 were from sunset to 10:00 P.M., and about 50 from midnight to 2:30 or 3:30 A.M. Since on the average two hours of observation per period is conservative, at least 900 hours of opportunities were available. One factor that greatly reduces the chance of detecting by ear the rise and departure of a single thrush is often the presence of several to many birds in flight calling more or less simultaneously; it is during periods of comparative quiet that the succession of notes characteristic of flight initiation can best be distinguished.

That many thrushes depart silently is unlikely in view of the universal tendency of either diurnally or—in the four instances recorded here—of nocturnally departing migrant birds of various species to utter diagnostic notes.

Furthermore, these four departures included not more than 2 birds each; although in each instance special effort was made to detect others during the ensuing hour or more, results were negative. The departure on September 6, 1949, at 2:16 A.M. (Atlantic Standard Time) occurred but a few hours before one of the greatest dawn flights of the year (Table 3); yet no other call notes were heard until 4:35. By 5:04 the last of 390 had passed. On the other hand the record of September 18, 1950, was made during a period when comparatively small flights were witnessed at dawn. The two instances of 1941 were experienced far up the York Valley at a time when very weak dawn and evening movements were passing. During this week of September 7 and 10 coastal migration of thrushes at Grand Grève was moderately strong both morning and evening.

Were one to assume that the great migrations recorded in Gaspé valleys consisted of northern birds, he would still have difficulty in accounting for the detection of so small a number of departures; for northern birds descend at dawn to feed and rest, and they must renew their flight during the following days. Yet none were recorded in the act. In view of evidence cited earlier in this paper (p. 71) the major portion of 300 thrushes in the Sandy Beach plateau area had already left before September 18. It is tentatively concluded that most of them departed at about the same date.

Thrushes were heard leaving the ground not only in the evening but, more important, in the later hours of the night. Consequently some, in one night, make longer journeys than others, provided the first to start continue flying all night as generally supposed. As yet none has been detected making a landing during the night. However, the observed ability of passerines to find new perches when disturbed while at rest with only the clear night sky illuminating dimly the ground and vegetation, probably enables them to do so when desirable (p. 65). Abundant evidence strongly suggests that all thrushes, whether in Gaspé or New England, at dawn descend to the ground within a brief period as the light intensity approaches the degree (0.01 to 0.02 f.c.) when penciled notes in one's field-book can be discerned, and the forest margin resolves into individual trees.

Calculations based upon 81 singing male hermits and olive-backed thrushes in 1949, on a square mile behind Sandy Beach that had suffered a forest fire 14 years previously, resulted in a conservative total of 300 probable migrants, hermits preponderating. Another square mile of coniferous forest about York Lake gave a figure of 145, with a majority of olive-backs. The entire York Valley, comprising both forested and cut-over areas, with more than 100 square miles of "burn" similar to the measured mile at Sandy Beach, must have produced about 103,000 migrant thrushes. This is far more than were heard, or calculated to have left the mouth of the valley. Hence there is no need to draw upon regions outside of the peninsula for migrants to make up the mere 7550 heard in flight in the fall of 1949. Rather it is necessary to account for the departure of the greater number through passes to river valleys south of the York. Many were detected entering that of the St. John, and a number from the latter crossing into the Grand River watershed.

Analyses of meteorological conditions pertaining to several especially interesting migratory movements suggest possible influence upon the birds by winds, but records of surface and high-level currents taken at the time of occurrence leave the issue in doubt.

While it is true the world over that not only geese, hawks, and other large birds, but passerines as well, migrate at considerable heights as seen with or without optical aid, many others pass comparatively close to the ground or water surface. The influence of meteorological factors on these flights is by no means always clear. In some the evidence supports the hypothesis that phenomena associated with a low-pressure area—clouds or precipitation superposed by high winds above—force the birds down. Other flights, often extending over several days, occur in fair weather. One may more safely attribute such series to departure of successive groups from a given watershed, or from areas more and more remote, than to the stimulus of a cold or warm front outside the field of observation. Especially in autumn a nearly continuous alteration of high- and low-pressure areas of differing strength cross the St. Lawrence, Gaspé, and the Maritime region. Data available fail to show that all heavy migrational movements there are directly correlated with the fronts involved. One series of flights suspected of originating outside the valley in which they were observed were the great ones of September 19 and 20, 1949 (cf. Appendix). In other regions some aspects of the relationship of cause and effect on certain occasions are already apparent (Thomson 1926, p. 290; Lowery 1946; Suffern 1949; Bagg et al. 1950).

In many other cases when moderate weather conditions prevail the influence of weather conditions appears doubtful if not negligible (Thomson 1926). Many heavy flights down the eastwardly and northwardly flowing Gaspé rivers under various combinations of meteorological factors render generalizations unsafe. The peninsula, although not bordered by such a wide body of water as the Gulf of Mexico, nevertheless has interesting geographical relationships somewhat similar to those of Yucatan, which Lowery (1946) has so well demonstrated. Bearing in mind that autumn and spring migrations are subject to some important differences, we still should expect certain similarities of migratory behavior on the part of transients from more northern regions. Future research should substantiate this belief. With regard to the thrushes that in great numbers descend the Gaspé valleys, and are regarded here as residents leaving their summer territories, further observations are needed before the stimuli concerned with their departure southward can be satisfactorily assigned.

The environmental releasers of some groups of individuals may differ from those of others; stimuli that cause departure in one case may be insufficient in others. Thus one can, perhaps, account for migratory movements in various sorts of weather.

SUMMARY

1. During six autumns' residence on the narrow, southeasterly projecting Forillon at the tip of the Gaspé Peninsula, diurnal passerine migrants and hawks were observed to enter its base, turn back at Cape Gaspé, and return to the head of the bay. Less than a dozen birds crossed the bay which nowhere exceeds 5 miles in width.

2. Most nocturnal migrants followed this same course. The only exceptions were a few thrushes.

3. Probably on account of their search for food, as well as a tendency to follow the coast, diurnal migrants avoid crossing even the estuaries of brooks, but ascend each one until they can pass almost from tree to tree. This procedure is repeated on the estuaries of large rivers, the Dartmouth, York, and St. John, which enter the Bay of Gaspé.

4. Striking evidence of the tendency to avoid water was observed at Cape Gaspé and at Peninsula which projects into the bay. On three different occasions small groups of sparrows and warblers turned back to the north shore after flying but a few hundred feet in an attempt to cross the bay.

5. Even a narrow bar 2 miles long, which practically closes the mouth of the St. John estuary, failed to encourage diurnal migrants to cross here; all ascended to the river's entrance 3 miles inland.

6. The majority of passerines from the interior descended the valleys and followed the south shore of Gaspé Bay to Point St. Peter, then flew around the Malbay, past Percé, to the eastern end of the peninsula.

7. A considerable number of robins, vireos, warblers, and fringillids diurnally ascended westward along the York and St. John. Evidence was obtained that these birds either passed over extensive blueberry burns, or through passes, into the watersheds of streams flowing southward toward Chaleur Bay.

8. Since, among nocturnal migrants, thrushes are the most readily recorded by their call notes, much study was devoted to them. The olive-backed thrush (*Hylocichla ustulata swainsoni*), the hermit (*H. guttata faxoni*), and Bicknell's thrush (*H. m. minima*) breed on the peninsula. Of these, the first two species nest abundantly throughout the region, as well as far north of the St. Lawrence. Bicknell's thrush is known to occupy the coastal highlands near Percé, and Mt. St. Alban near Cap des Rosiers. It breeds more commonly in the higher Shickshock Mountains in west-central Gaspé.

9. A description of the ground notes and flight calls of these three species is given.

10. Except for one large evening flight (at Maria) of 450 birds, fully 90 per cent of the migrant thrushes were recorded in the hour before dawn.

the first calls are heard when the twilight intensity reaches about 0.0005 f.c. All descend to the ground to feed and rest as the intensity increases to between 0.01 and 0.02 f.c. That migrant thrushes are seldom heard between 11:00 P.M. and 3:30 A.M. was confirmed during more than 50 observation periods of two to three hours during 12 seasons in Gaspé.

11. Since thrushes do not gather into flocks, migratory restlessness is difficult to observe. It was detected as a short movement away from the nesting territories during the few days preceding disappearance.

12. Robins form flocks as great as 200 in number, and during the autumn feeding period on the blueberry grounds exhibit increasing restlessness, especially marked upon the day of departure.

13. The actual departure of small groups of thrushes was witnessed on four occasions. Two of these occurred in early evening, one at 2:16 A.M., and another at 3:46 A.M. The meteorological conditions and light intensities differed greatly. In one instance the birds could be seen at the edge of the forest at 6:53 P.M. ($0.01^{\pm}$ f.c.); at the other extreme (3:46 A.M.) the intensity did not exceed 0.0002 f.c.

14. Since thrushes are thus shown to leave the ground at various times during the night, it is inferred that the great dawn flights of vocal migrants comprise, not large flocks of birds that have flown all night from some distant source, but rather an accumulation of small groups that have chiefly arisen, perhaps after midnight, from various areas within a given river system. This conclusion is supported by the greater numbers heard in the lower parts of valleys.

15. Although the descent of thrushes to the ground before dawn has not been recorded, they are believed able to do so without harm on ordinary fair nights when the permanent aurora, stars, etc., render individual trees apparent to man. Many instances are cited in which passerines, disturbed from sleep by the passing observer, have easily found their way to another perch.

16. Upon these grounds it is suggested that not all thrushes fly throughout the night; that some arise within two hours of dawn and migrate from 30 to 60 miles before daylight brings them down. Others may depart in the evening and continue till dawn, some nine hours at 30 m.p.h., covering more than 250 miles. A few may even descend during the night thus curtailing the distance.

17. The period of thrush migration in Gaspé extends from August 18 to the last week in September. First to depart are the olive-backs, followed and overlapped by hermits and gray-cheeked thrushes, including Bicknell's. Apparently adult birds and first-brood immature precede the second-brood young. A few hermits continue passing until late October, doubtless birds from far north.

In Gaspé the flight-lines of thrushes, here narrow-front migrants, are consistently down valleys and along the coasts—eastward at least from Chloridorme near the northernmost point of the north shore, and southwestward from the Ste. Anne des Monts region. At the eastern end of the peninsula the coastal migrants turn southward to follow the Chaleur Bay shore. On the west many pass southward through the Matapedia Valley. Evidence has been recorded that thrushes pass southward up the Ste. Anne River to enter the southward-trending valley of the Little Cascapedia. At Lake Ste. Anne, lying in the low divide between these two rivers, preliminary studies showed that birds rising from the north end of the lake flew north (downstream), and that others apparently flew southward from the south end. But evidence indicated that some thrushes from the southeastern slope of Mt. Lyall also passed northward into the Ste. Anne Valley.

18. From the interior highlands of Gaspé thrush migration proceeds radially down rivers that flow northward to the St. Lawrence (Ste. Anne and Fox) as well as eastward (Dartmouth, York, St. John, Malbay), southeastward (Grand, Bonaventure, and presumably the Pabos and Petite Riviere as well), and southward along the Cascapedia and others. My own observations at the divide proved that movements were simultaneous northward down Fox River to the St. Lawrence and southward along Mosher's Brook to Gaspé Bay. Through the coöperation of other observers simultaneous descent of the York (eastward) and the Ste. Anne (northward) was established. One may assume with confidence that at the same time others were descending the Cascapedia southward.

19. The directive stimuli therefore cannot be meteorological; for at least in eastern Gaspé, atmospheric pressure, wind, temperature, and humidity at any one time vary but little in the several valleys. This radial migration also rules out light as a directive; in the early dawn twilight thrushes descending the York might be conceived as reacting positively to increasing intensity in the eastern sky, but those in flight along the Ste. Anne and Cascapedia would not be subject to this stimulus.

20. One external factor to which all these migrants are subject is the generally descending horizon line of the valleys. This is readily visible on all but the darkest nights. Birds leaving tributary valleys consistently turn down the main valley even though their home brook may curve temporarily in the opposite direction. Two exceptions to down-valley thrush flight tend to prove the rule. 1) A small group detected flying diagonally upstream across the York Valley did so in the broad featureless amphitheater into which Mississippi Brook descends from the north. To these birds was presented a mountain horizon of only gentle downward slope, possibly not a sufficiently strong stimulus. The stream itself appears to be of little importance, for not only is it dark and invisible at night, but in the broader valleys many thrushes fly at elevations barely above the treetops and far to one side of the river. 2) Southward migration is strong in a northwardly trending part of the York Valley.

21. Among thrushes reaching a pass from the mountains on either side some groups turn northward and others, within a few moments, southward (pp. 79, 188). Two interpretations are suggested; 1) entrance of the pass at somewhat different points from which the horizon presents a different appearance, 2) different populations with different inherited or traditional

paths are represented. Clearly the direction taken here cannot be determined by meteorological factors.

22. Analysis of wind direction during several migration seasons fails to support it as an important factor influencing the numbers and flight direction of Gaspé migrants. Large thrush movements have been recorded only on nights of relatively low wind velocity. Diurnal movements of warblers, etc., especially on the Forillon, occur both "with and against" the wind. The fact that westerly winds usually prevail on mornings when good flights are recorded is attributed to the predilection of migrants for fair weather, which is generally accompanied by west winds. In an extraordinary exception to the "fair weather rule" two strong flights on consecutive cloudy mornings descended the upper Cascapedia. On the first, the wind was westerly, on the second, it blew from the east. While each followed closely spaced cold fronts they failed to await fair weather.

23. Upon analysis, temperature also fails as a determinant of migration here. Movements occur both during high and low, as well as on rising and falling temperatures. Contrary to the general expectation several of the greatest thrush flights passed on very warm mornings. Of 39 flights along the south shore of Gaspé Bay only 11 followed by one, two, or three days the incidence of low temperatures (about 6°). Average temperatures during periods preceding first seasonal movements on four consecutive years showed no correlation.

24. Atmospheric pressure in itself cannot be regarded as a stimulus initiating migration. Thrush flights occurred on low or falling pressure, also on steady, rising, and high pressure. Furthermore, crows, hawks, and others, within a few moments frequently rise or descend 1000 feet. This involves a pressure change greater than do most of the transitions between lows and highs that traverse the region. Meteorologic charts in the Appendix present the conditions pertaining to several major migratory flights.

25. Though not so consistently as with *Sitta canadensis,* thrush flights occur oftenest in fair weather. But not always does their departure so closely follow the passage of a cold front that the latter can be regarded as the releaser of resident Gaspé thrushes.

26. Departure of thrushes for the south is not attributed to the general decline of food supply, for during late August and the first half of September fruits are still abundant. Many insects and snails are also available. It is nevertheless true that caterpillars, an important type of summer food, largely disappear in early autumn. Possibly the change in quality rather than quantity of food may help to arouse migratory restlessness.

27. A review of pertinent literature on photoperiodicity in relation to endocrines leads to the acceptance of change in the duration and intensity of daily light periods as an important factor initiating migratory movements among birds that have reached the proper physical and physiological conditions. Curtailment of feeding periods and lengthening of the foodless night intervals must contribute to the bird's psychologic state—in other words, to restlessness, migratory urge, or *Zugunruhe.*

One advantage of the photoperiodic theory is that it may account for occurrence of migration flights of thrushes during warm weather as well as cold.

28. However, the cumulative days of illumination preceding migration in four years (1947–50) show only those of 1947 and 1950 supporting the periodicity hypothesis.

29. Diurnal migrants often respond to sunlight by changing their course. At sunrise, warblers, nuthatches, and others are attracted to the tops of trees first illuminated. With the progress of the sun they fly at lower levels along the eastern slopes. As the tips of trees on the western side later receive direct light the birds cross the ridges more and more frequently. Individual deciduous trees (e.g. white birch) standing in open fields present a luminous glow in the early sunlight that often attracts birds. Toward the sun itself, while low in the east, individual warblers and robins may suddenly alter their line of flight with accelerated speed.

At dawn migrant thrushes along the York on several occasions were observed to change from their direct down-valley course to one exactly toward the point of greatest sky light intensity at which the sun would later rise. Evidence is presented that this bright sky area sometimes attracts a small percentage of migrants northeast at a mountain divide where the majority are passing southward.

30. The actual stimulus to departure may not be specific; to a bird prepared for migration any one of several releasers may set it in motion. Hunger, exhilaration at the termination of a passing storm, a sudden gust of wind, or other disturbance may tip the balance. On two occasions when departure of thrushes was observed, my progress through the area possibly provided the immediate stimulus.

31. Among the migrants leaving, or traversing Gaspé initial southward orientation appears non-existent or very weak. We have seen that from the interior highlands thrushes descend valleys that radiate in all directions. Furthermore, they do not consistently cross divides southward (Lake Ste. Anne and Second Fork–Grand River passes). The one bit of positive evidence is that thrushes migrate upstream only along rivers that flow northward. This occurred not only throughout the length of the Fox and Ste. Anne rivers, but very impressively along only that section of the York which flows for a few miles northward from the Caribou Brook bend to that near Whitehouse.

Nocturnally migrating thrushes have not been recorded ascending eastward-flowing streams; they are therefore regarded as being more strongly oriented than their relatives, the diurnally moving robins (*Turdus*) that often do so. With the latter, however, other factors are very likely influential. But not all thrushes that enter the base of the Forillon continue southward across the bay; many turn back northwestward along the shore.

32. It is to be noted, however, that thrushes do not retreat northwestward to Cap des Rosiers and beyond, although diurnally migrating warblers not infrequently do so. Thrushes show little evidence of using the "trial and

error" or "random wandering" method; upon reaching the coast they follow it in a direction leading at once or eventually south. Thus far we have noted only one instance (Cape Haldimand at the mouth of the St. John estuary) of thrushes turning toward the head of Gaspé Bay along its south shore. Further study of this tendency is planned for the strategic area about Black Cape on Chaleur Bay.

Having in mind the ability of birds to return accurately to both winter and nesting territories one turns almost unavoidably to the assumption that tradition and personal memory, or at least recognition, are concerned in the migratory behavior of these birds. No other theories yet proposed are wholly satisfactory.

33. Since thrushes occupy the island of Anticosti and the Magdalens, as well as Newfoundland, it is apparent that north-south fly-lines across the Gulf of St. Lawrence exist. Although not as yet recorded, it is believed that in autumn some birds reach Gaspé from Anticosti (visible across 40 miles of water). Doubtless many birds follow the north shore of the St. Lawrence southwestward.

34. That the thrushes migrating from and through the interior of Gaspé are chiefly local residents departing southward—not northern representatives that have descended from a concourse of birds sweeping southward over a broad front at high altitude—is concluded from the following observations: both evening and dawn movements are mainly radial in valleys, and numbers greater at lower ends; numbers smaller in tributary valleys that lack good passes at their heads; no faint call notes high above the ground, few above 300 feet; none above the tops, not only of the highest Shickshock Mountains (4000 feet), but even over mountains of moderate height; preliminary studies reveal no high-level migrants crossing the moon's face; local population is much greater than required to account for the number of migrants recorded.

35. From two typical sample plots of one square mile each, one in a "burn" undergoing reforestation (optimum environment of hermits), the other in virgin forest including a lake margin (best for olive-backs), territorial counts respectively of 104 (81 hermits + 23 olive-backs), and 60 (chiefly olive-backs) were calculated to produce 300 migrants per square mile of the burn type (hermits raise two broods) and 145 on the forest type. The entire York River valley, embracing about 175 square miles of burn and cut-over areas, and 350 of forest, may furnish over 100,000 migrants annually.

36. Since only 7550 thrushes could be recorded leaving the valley mouth, it is inferred, and partly proved, that many use mountain passes into the St. John, Grand, Pabos, and Bonaventure valleys leading southward—possibly to be interpreted as further evidence of an orienting power.

37. Since the calls of some migrant thrushes are not uttered continuously while within audible distance of the recorder it is quite possible that during the night many pass him, unheard, on their way down the valleys.

38. Relationship between dates of thrush migration in Gaspé, New England, and New York State is suggested. Autumn departures of cormorants

from the Forillon's sea-cliffs are recorded. In some years large numbers of red-tailed, broad-winged, and the immature of marsh and goshawks pass down the Forillon to return northwest. Their further course has not been satisfactorily defined.

APPENDIX

MEASUREMENT OF LIGHT INTENSITIES

A Photrix Universal Photometer, Model A, was used to determine light intensities in foot-candles. Its calibrated range is from 0.005 to 25 foot-candles. On some occasions the instrument reading was made directly. On others, a series of four black crosses, graded in size, was made in the field-book. To these were related the records that later were measured by the instrument under similar out-of-door illumination. This method was found the more satisfactory, both because it obviated the carrying of an instrument, and especially because the photometer required placement in a strictly horizontal position in order to measure low intensities.

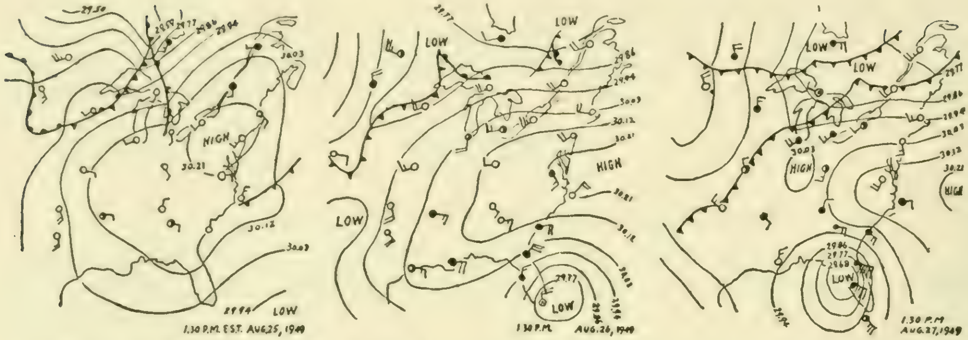
0.00002	f.c.,	estimated from the next, by rate of movement of indicator. The earliest thrushes of the morning flights sometimes began calling before the instrument registered.
0.0002	f.c.,	lowest possible reading, with aid of lens and flashlight. Below 0.00002 one could barely see the position of, but could not read, No. 4X, the heaviest penciled indicator in the field-book.
0.0010	f.c.,	first able to read this No. 4X by regarding it with eye slightly turned aside, thus taking advantage of "rod" vision.
0.002	f.c.,	average intensity at which greatest number of calls are heard.
0.007	f.c.,	read No. 4X easily.
0.02	f.c.,	most birds have descended to the ground by the time this intensity is reached.

FIRST MOVEMENTS OF 1949: AUG. 19, 23, 26

To the account of the first three observed migratory movements of 1949 presented in Table 3, and on pages 94–96 we may profitably add some of the weather maps of the period from August 25 to 27 (Fig. 27).

The first 9 migrants of the year passed Sandy Beach on the 19th as a low cool front was crossing the peninsula, accompanied by a wind shift from south-southwest at dawn to north-northwest at 1:30 P.M. Pressure fell to 29.41 on the 20th but had risen to 29.86 on the 21st. No thrushes were recorded on either of these days, or on the 22d as another cool front entered Gaspé.

The 23d brought a good movement of 115 birds. The low was centered over the peninsula, and nearly stationary—pressure 29.77 at dawn and the wind W–3. At Caribou, Maine, the surface wind direction at 10:00 A.M. was west-southwest–15, at 2000–5000 feet west-southwest–20, and at 10,000 feet west-southwest–38. In other words westerly winds were of sufficient force conceivably to concentrate migrants in northeastern Gaspé. Yet one hardly feels the need of drawing upon wind to bring 115 birds to Gaspé Bay; for such a small number might have left any one of several valleys tributary to the York or Dartmouth rivers.

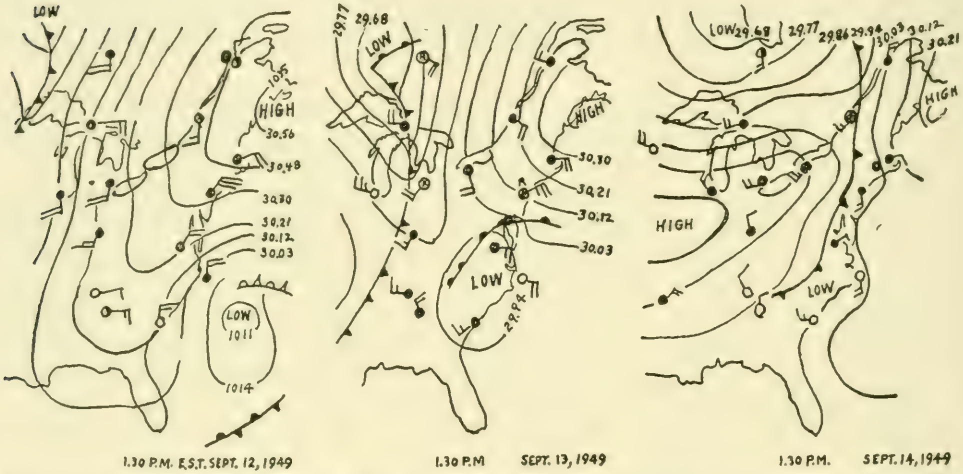

29.50
29.77
29.86
29.94
30.03
HIGH
30.21
30.12
30.03
29.94
LOW
LOW
LOW
29.86
29.94
30.03
30.12
30.21
HIGH
30.21
30.12
LOW
29.77
LOW
LOW
LOW
29.77
29.86
29.94
30.03
30.12
30.21
HIGH
30.03
HIGH
29.86
29.77
29.68
LOW

1.30 P.M. E.S.T. AUG.25, 1949

1.30 P.M. AUG.26, 1949

1.30 P.M AUG.27, 1949

Figure 27. August 25–27, 1949, showing cool and warm fronts (cf. p. 100).

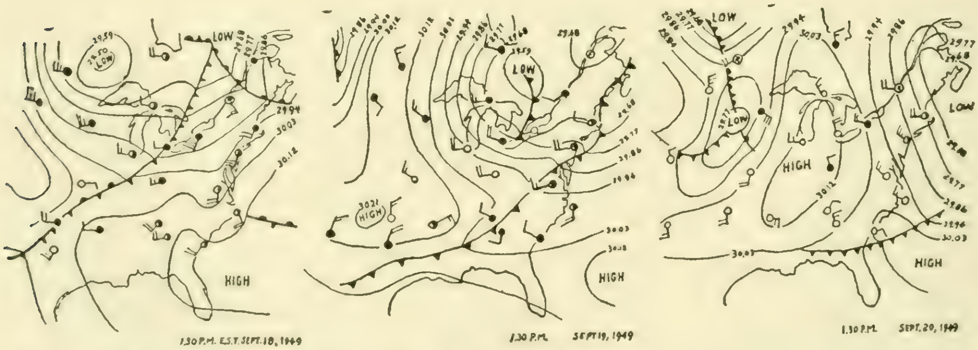

LOW
HIGH
30.56
30.48
30.30
30.21
30.12
30.03
LOW
1011
1014
29.77
29.68
LOW
HIGH
30.30
30.21
30.12
30.03
LOW
29.94
LOW 29.68
29.77
29.86
29.94
30.03
30.12
30.21
HIGH
HIGH
LOW

1.30 P.M. E.S.T. SEPT. 12, 1949

1.30 P.M SEPT. 13, 1949

1.30 P.M. SEPT. 14, 1949

Figure 28. September 12–14, 1949. Falling pressure prevailed while many thrushes descended York Valley on the 13th and 14th (cf. p. 104).


29.59
29.50
LOW
LOW
29.94
30.03
30.12
HIGH
LOW
30.21
HIGH
30.03
HIGH
LOW
LOW
HIGH
29.77
29.68
LOW
29.77
29.86
29.94
30.03
HIGH

1.30 P.M. E.S.T. SEPT. 18, 1949

1.30 P.M. SEPT. 19, 1949

1.30 P.M. SEPT. 20, 1949

Figure 29. September 18–20, 1949, at time of heavy migration of thrushes down Cascapedia River (cf. p. 104).

Light east surface winds and showers ushered in the dawn of August 24. Yet they were probably westerly at higher levels; at Father Point the weather map records them as west–5 at 1:30 P.M. Caribou had stronger 10:00 A.M. currents, north-northwest–20 at the surface, north-northwest–20 at 2000–5000 feet, and northwest–22 at 10,000. Only 8 thrushes passed Sandy Beach.

A comparison of the data on these two mornings reveals a difference in the wind direction at dawn when the birds were observed. At the ground surface it was light west on the 23d (115 thrushes) and light east the next morning (only 8 thrushes). It thus appears that, if winds were a factor, they were those at the surface, not at high elevations.

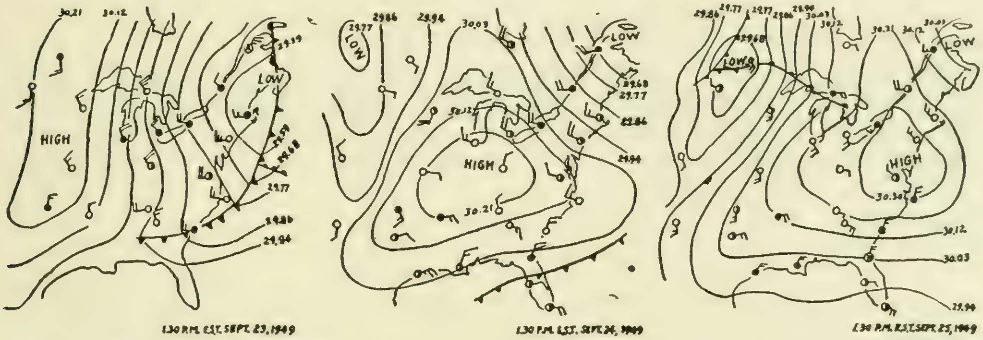

HIGH
LOW
1:30 P.M. E.S.T. SEPT. 23, 1949
LOW
HIGH
LOW
1:30 P.M. E.S.T. SEPT. 24, 1949
LOW
LOW
HIGH
1:30 P.M. E.S.T. SEPT. 25, 1949

Figure 30. September 23–25, 1949, last important movement of the year—westward along northern escarpment of Shickshocks between Ste. Anne des Monts and Cap Chat (cf. p. 105).

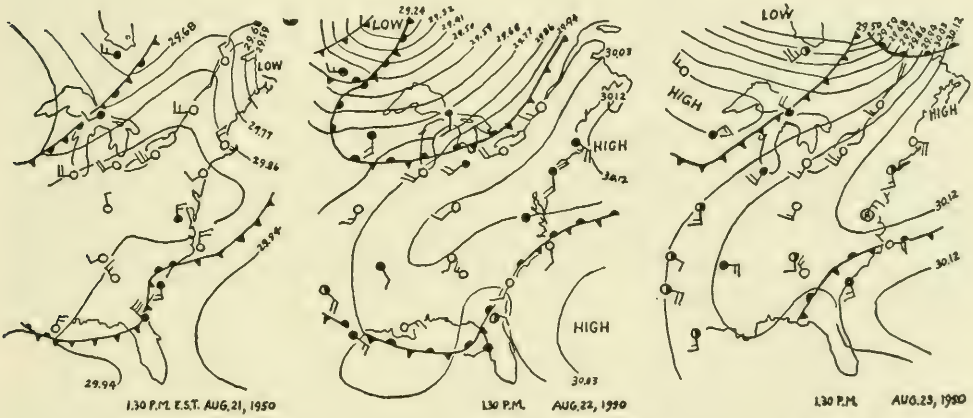

LOW
1.30 P.M. E.S.T. AUG. 21, 1950
LOW
HIGH
HIGH
1.30 P.M. AUG. 22, 1950
LOW
HIGH
HIGH
1.30 P.M. AUG. 23, 1950

Figure 31. August 21–23, 1950, when the first movements of thrushes were recorded (cf. p. 71).

Further evidence that wind has little effect is provided by the conditions obtaining on August 25 (Fig. 27). Fresh west wind at the surface, north-northwest–18 at 2000–5000, and north–24 at 10,000 feet. Air currents thus were stronger near the ground and at high altitude, yet no migrants whatever appeared.

What of the great flight—650 thrushes—on the following morning? The weather map of 1:30 P.M., August 26, shows a limited occlusion approaching from the west and surface wind west–15. At dawn it had been west–5. At Caribou the records are, surface south-southwest–10, 2000–5000 feet west-northwest–18, 10,000 feet west-northwest–38.

In support of high-level migration one may point to the strong 10,000-foot level winds (38 m.p.h.) on the 23d and 26th when good thrush movements were recorded.

It should be stated that during this entire period the temperature never dropped below 10°C.

SEPTEMBER 11 TO 13, 1949

The flights of 225 and 135 thrushes on September 13 and 14, 1949, were presented on page 104 as examples of migration on falling pressure (Fig. 28). The data then available from field notes at dawn and weather maps at 1:30 P.M. can now be amplified:

Date	*Dawn sky*	*Dawn temp.*	*Dawn surface wind*	*Caribou, Me. Avg. direction & force at surface 10:00 A.M.*	*Caribou, Me. 2000–5000 ft.*	*Caribou, Me. 10,000 ft.*
Sept. 11, '49	Fair	4.0°C.	0–W–5	SSE–6.8 m.p.h.	W–4 m.p.h.	NW–24 m.p.h.
" 12, "	Fair	6.5°C.	0–W–5	SSE–9.7 "	SW–3 "	WSW–9 "
" 13, "	Clear	10.0°C.	W–5	SSE–9.1 "	SW–4 "	W–16 "
" 14, "	Cldy.	9.0°C.	0–W–5	....	....	....

SEPTEMBER 23 TO 25, 1949

While it is believed that the 196 thrushes recorded September 25, 1949, flying west at St. Octave at the foot of the Shickshock escarpment had descended the Ste. Anne River, the meteorological conditions were such as to permit a flight across the St. Lawrence (Fig. 30). Field records for this morning and the two preceding were as follows:

Sept. 23	*Sept. 24*	*Sept. 25*
Low "Stationary" front, 29.59	Low receding slowly E. Pressure beginning to rise—29.50–59	Pressure rising, 29.94
Cloudy & foggy	Cloudy & rainy	Cloudy after rainy night
Dawn cold from northeast	Cold, direction not recorded	Clouds from north
Wind at surface northwest	North—15 m.p.h.	Calm at surface
10°C.	Warm, 14°C.	11°C.
No thrushes	No thrushes	196 thrushes

Weather data from Father Point at 1:30 P.M. appear below:

Rain NE 19–24 8°C.	Cloudy WNW–15 14°C.	Cloudy NW–10 9°C.

At 2000 feet above the surface winds may have been:

East–40	North-northwest–30	North–20

From the data in Figure 30 it appears that northerly winds for three days, including the morning of September 25, 1949, on which the 196 thrushes were heard, may have aided them in crossing from the north shore of the St. Lawrence. Unfortunately not a single thrush could be found after dawn. The calls, however, were typical of hermits. No gray-cheek notes were heard, but the source of these birds would have been no more certain had this species been present, for both races might have crossed the river, while resident *H. m. bicknelli* could have descended from the high Shickshocks.

The weather of August 20–23, 1950, as mapped (Fig. 31), appears to have been capable of inciting migratory movements. Indeed, the first 3 migrant thrushes of the season passed Sandy Beach on the 21st (low center, wind N–5), and 12 followed on the next morning as another cool front approached. Pressure had become high—30.03, clear, wind southwest–10, cool, 9°C.—but had again begun to fall toward a deep low west of James Bay in northwest Ontario. During the evening of this day (22d) the cool front passed through Gaspé. Next dawn was still cooler (8°C.), calm to southwest–3, as a "warm" front with falling pressure curved in from the southwest. As so often happens the station from which weather data is most desired failed on three of these mornings to report in time for the drawing of the maps. However, the surface wind on the 23d was recorded at Caribou, Maine, as south-southeast–11 at 10:00 A.M. and at Chatham, New Brunswick, as south-southwest–9 to 16 throughout the day. At Chatham the wind was similar in direction and speed at 2000 to 5000 feet, and southwest but stronger—30 m.p.h.—at 10,000 feet.

It is conceivable that these high-level winds may have carried into Gaspé from western Quebec some of the 205 thrushes recorded on this morning of August 23.

The map shows an occlusion was occurring northwest of Gaspé in Quebec. Below appears a vertical section through the Gaspé–James Bay region (Fig. 32), constructed from my own data taken at dawn in Sandy Beach, the radio forecast, and the U. S. Weather Bureau Map as drawn at 1:30 P.M.

AUDIBILITY OF CALL NOTES

With respect to the distance at which thrush notes may be heard (p. 49), it is theoretically true that, on the basis of spherical sound waves emanating from a point, calls from overhead should be heard at distances equal to those uttered on the ground. In Figure 33, OD = OA; O represents the observer, A the bird on the ground and D a migrant exactly overhead. However, in the field two other factors must be taken into account, namely the bird's trumpet-shaped beak and the direction toward which it emits the sound. OA will be greatest when the stationary bird faces O, shortest when the note is delivered in the opposite direction. Furthermore, reflecting surfaces, including vegetation, may affect the result.

Turning to the bird in undeviating flight, still another variable enters our calculations; as he approaches, reaching approximately the imaginary surface AD, and assuming that his bill points directly forward, he will emit notes more directly toward O the lower his elevation. When first heard migrants at successively higher levels (B, C) will in horizontal distance be nearer to O, and directly over it at D. But before attaining this point the bird will have been emitting the call notes less directly toward the observer, and beyond D this effect should be more rapid. Therefore one concludes first, that an approaching migrant about to pass above the listener will first be heard at a greater distance, OB′, than at the point, E′, where its receding calls become inaudible; second, that the maximum height above the earth, OD′, at which a bird directly overhead can be heard will be somewhat less than OA measured upon the ground (p. 49). These two effects doubtless diminish the farther to one side of the observer the bird's path carries it.

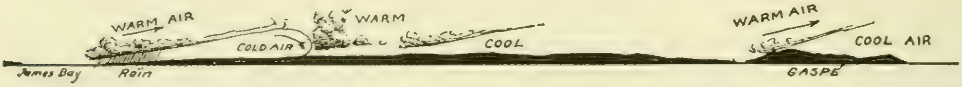


Figure 32. Vertical section of the atmosphere from James Bay to Gaspé, August 23, 1950 (cf. p. 106).

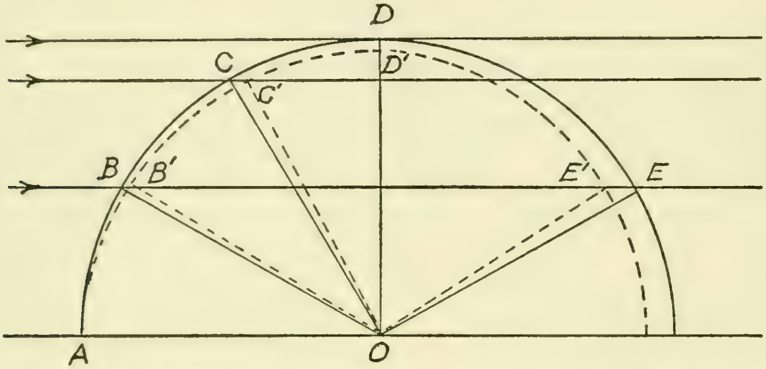


Figure 33. Relation of distances and positions of thrushes to the audibility of call notes. O = observer; OA = maximum distance on ground, 2000 feet; OD = distance toward zenith. Arrows indicate flight paths at various heights.

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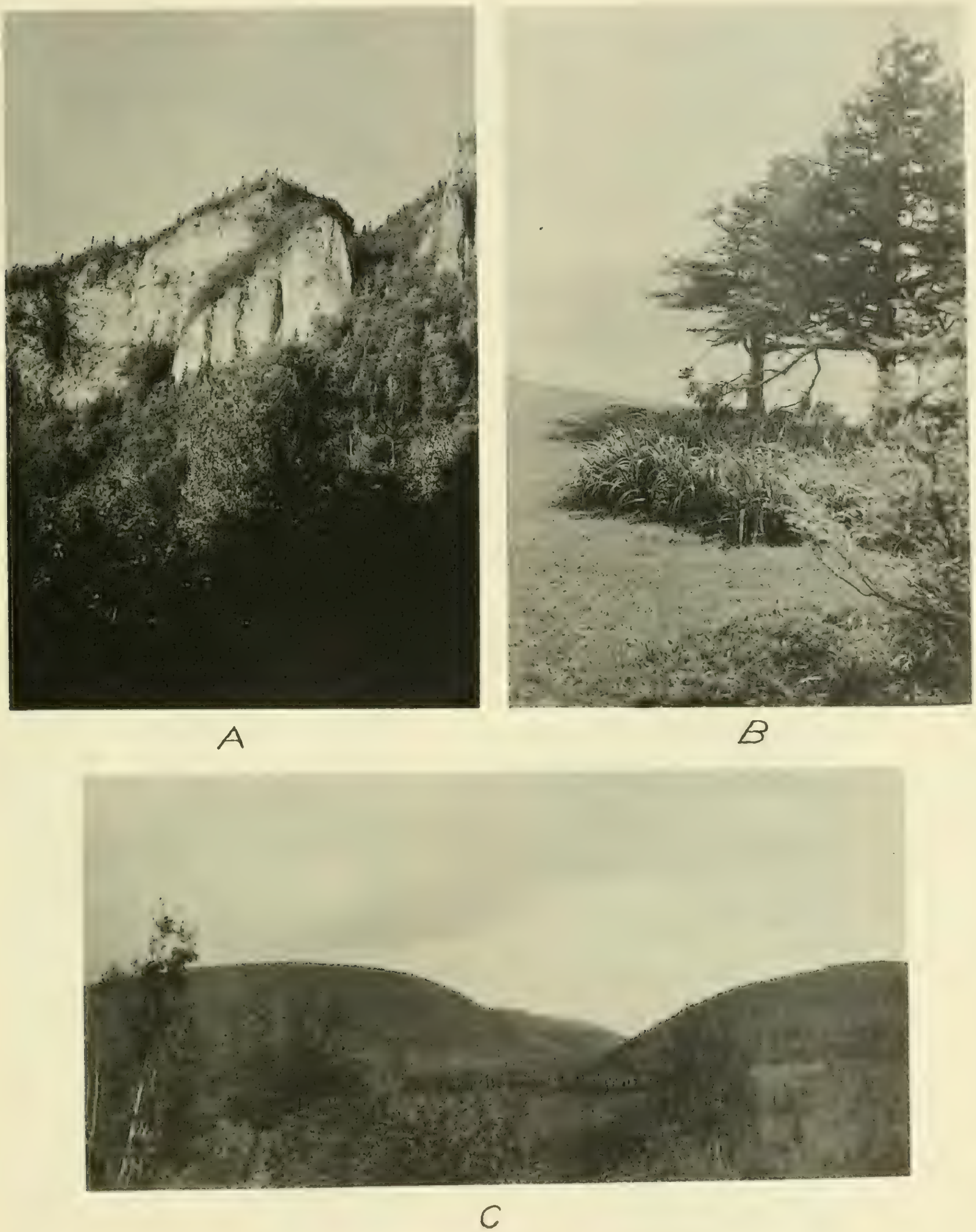

PLATE 1

SCENES OF UNUSUAL MIGRATIONAL BEHAVIOR

A. The Chimney.
B. Pasture, with blue flags (*Iris hookeri*), and spruce, at brink of Gaspé's eastern cliff.
C. Mississippi Notch on Brook 35.

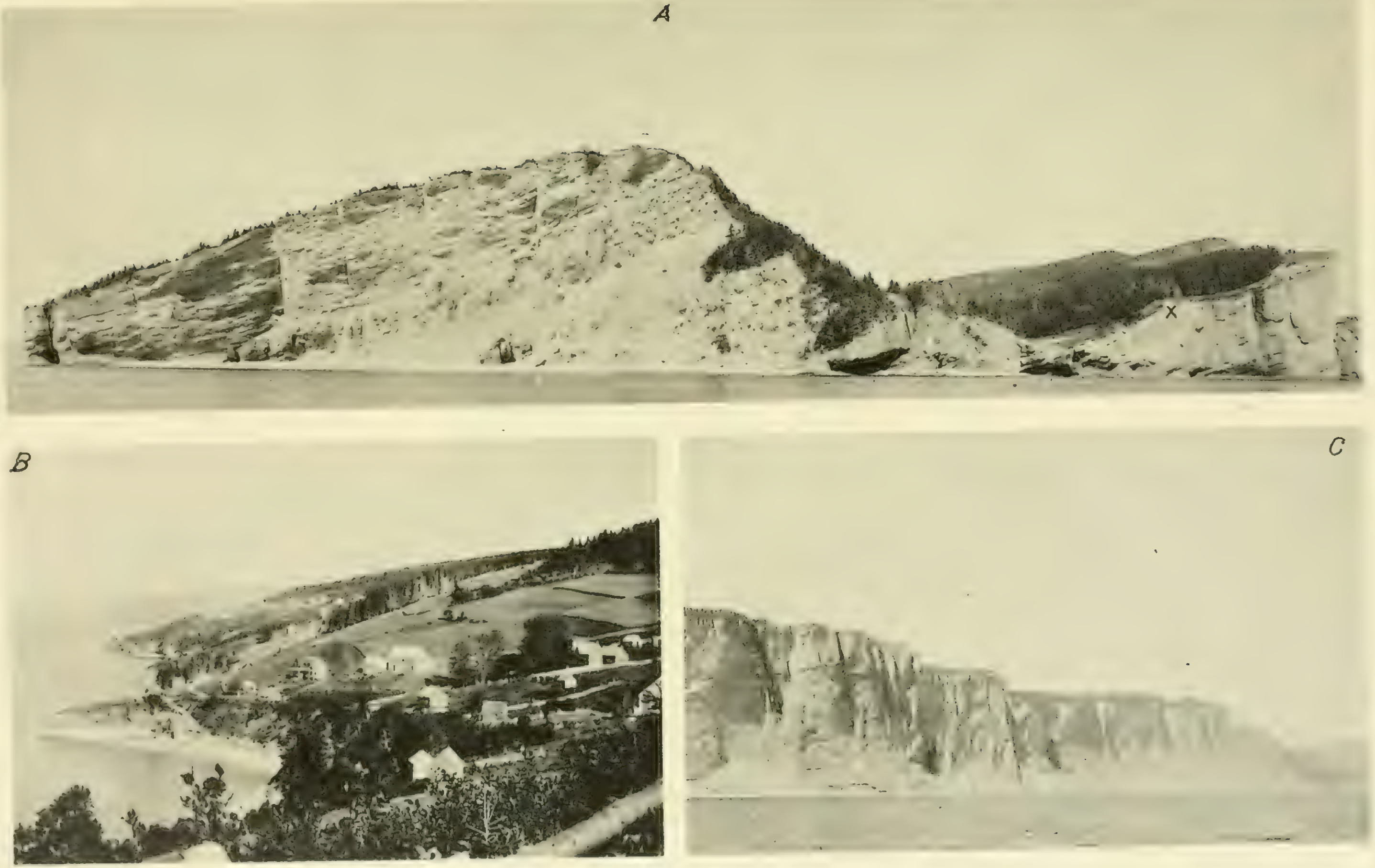

PLATE 2

THREE COASTAL VIEWS OF THE FORILLON

A. Terminal cliffs of the Forillon.
B. View of the Forillon's slope to Gaspé Bay, from Indian Cove, west.
C. View toward Cape Bon Ami along the Forillon's northern cliffs.

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MAR 24 1953

FALL BIRD MIGRATION ON THE GASPE PENINSULA

by S. C. Ball

Yale Peabody Museum of Natural History, Bulletin 7 - 1952

Errata

Page	
1	Paragraph 1, line 12, *for* east *read* south.
102	Paragraph 5, line 4, *for* Fig. 20 *read* Fig. 19.
106	Paragraph 2, line 9, *read* immediately by.
130	Paragraph 6, line 6, *add* not *after* would.
152	Paragraph 4, line 5, *for* southernmost *read* centralmost.
153	Paragraph 4, line 8, *for* 465 *read* 265; *for* 170 *read* 100.
172	Paragraph 2, line 14, redpoll equals yellow palm.
172	Paragraph 2, line 20, *for* Ontario *read* Erie.

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